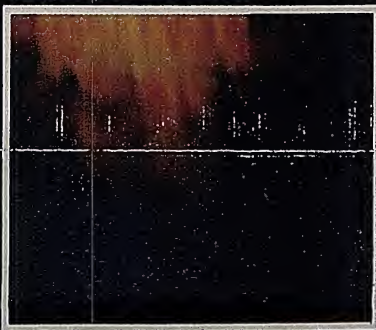
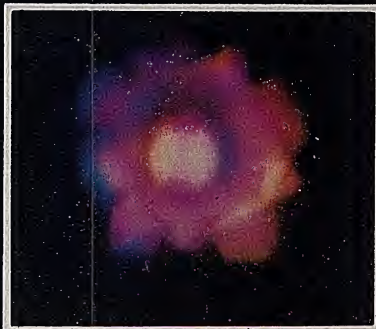
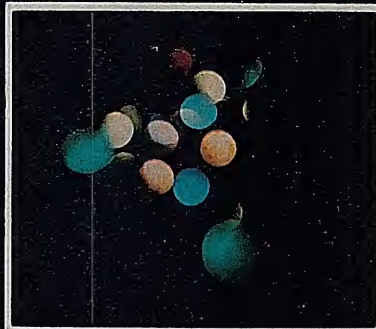
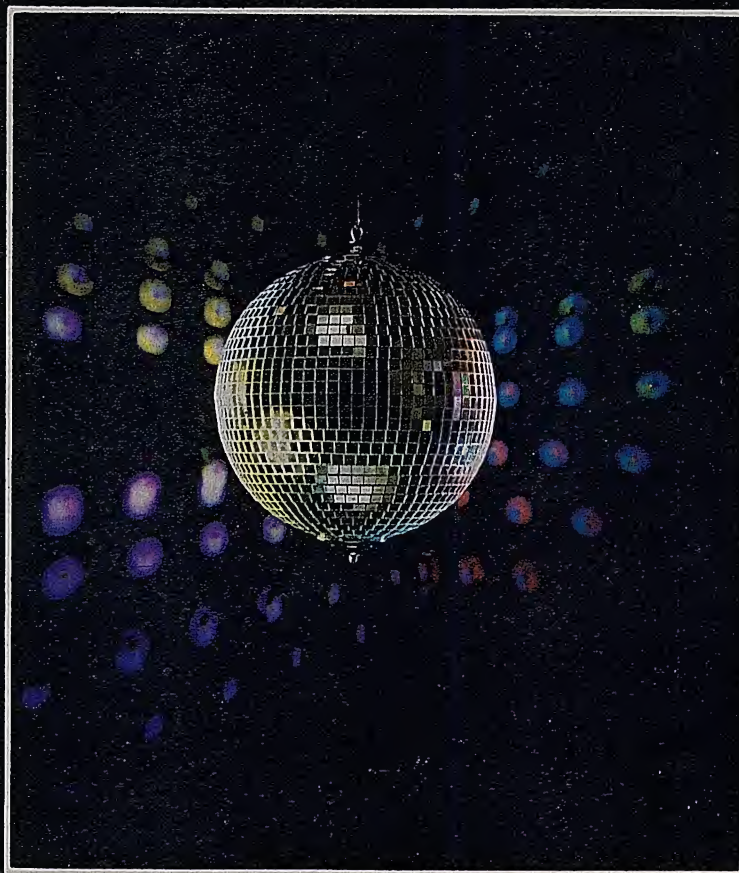
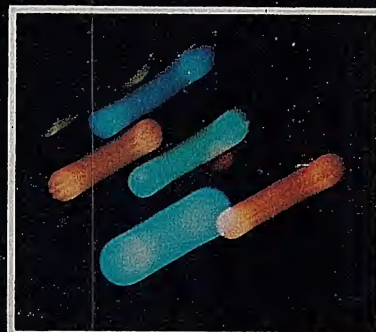
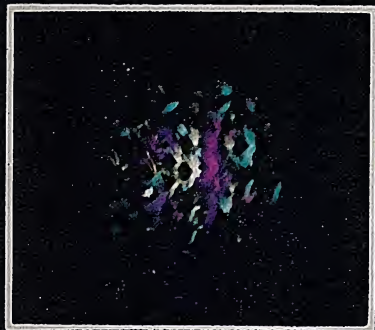


THE
EDMUND

Unique Lighting

HANDBOOK



THE
EDMUND

Unique Lighting

HANDBOOK

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PREFACE

This book is an introduction to the exciting world of unique lighting. Discos, light shows, multi-media presentations and multi-image displays are becoming more and more a part of our lives. As with any new industry, amateurs and professionals have a difficult time keeping abreast of the various developments in their field. This book is an attempt to encapsulate the myriad facets of technology associated with the art of sculpting light. It does not touch on television, movies or theatrical lighting—each of which would need a book in itself. Many of the techniques explained in this book can be used in any or all of those fields. The book is also not totally comprehensive. Every day new pieces of hardware are being introduced and it would be impossible to itemize each innovation. It does, however, give a representative sampling of all the areas of unique lighting and describes each aspect of the field in detail. We have chosen those items which are either most financially reasonable, most reliable or, in some cases, most dramatic, to serve as a basic outline of the unique lighting arts.

Part one is a brief description of projectors that can be used for straight slide presentations or special effects lighting. It deals with 35 mm projectors and overhead

projectors and introduces possibilities for modifying each.

Part two deals with the art of sculpting light. It is divided into several chapter headings as you'll see in the index. Many of the chapters could have been joined but we feel that for reference, they are better sub-divided, even if some of the material is closely related.

The remainder of the book deals with a miscellany of information. "Screens" should make you aware of the various options you have in materials for projection. "Slides" should serve as a stimulus to your imagination; there's no end to the amount of information which could be written on slides, but rather than give a step-by-step description of technique, we hint at projects for you to develop. A brief description of basic terms in audio/visual (A/V) and a look at available hardware ought to whet your appetite for a gourmet's delight.

Lasers and holography are recent arrivals and have a long way to go. It's our hope that you'll be involved in the development of the exciting, new products and techniques that are sure to come out of this area.

We hope that as you open the pages of this book, you'll be opening up a new world of learning and pleasure.

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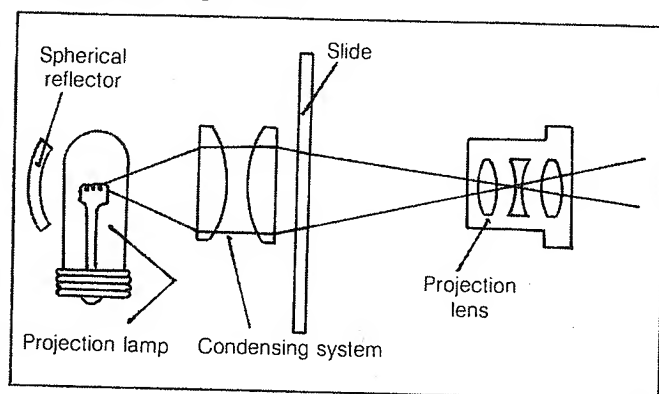
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We wish to thank the librarians of the Library of Congress and the Free Library of Philadelphia for their kind assistance in gathering certain historical material for this book. We would particularly like to cite the efforts of Miss Elizabeth Hartman and Mr. John Angell for their cooperation in gathering photographic material.

We also wish to thank Mr. Crawford Greenewalt and Mr. Thomas Wilfred, Jr. for their valuable cooperation in furnishing photographs illustrating the pioneer work of their respective parents, Mary A. Greenewalt and Thomas Wilfred, Sr. Lastly, we'd like to thank the Theodore Presser Co., Hutchinson Co., Ltd., and the publishers of High Fidelity Magazine and Musical America for granting us permission to reprint several of the illustrations.

35 MM PROJECTORS

The fundamental components of the old magic lanterns are still present in the modern projector: a light source, reflector, a condensing system, a projection lens, and a slide. The electric lamp has replaced the kerosene lamp as a light source. More important, modern slide-painting techniques and faster slide changing have revolutionized light shows.



There are two basic kinds of 35 mm slide projectors that are used for shows: a special effects projector with a slot that allows wheels to turn between the condensing system and the lens, and a carousel-type projector for the projection of pictorial images. For "fade & dissolve" shows, we will be referring to the Kodak Ektagraphic series of projectors which interface with all dissolve and programming equipment.

If you already own a projector, and want to do special effects with it, there are motors and wheels available which can be used to great effect. As in any field, with slide shows there is a huge range of sophistication.

Let's start with single-projector shows.

Light shows today depend more and more on the fast changing of a series of slides. Slides in a series can tell a story or illustrate a free-wheeling train of thought. Quick slide changes, with little or no black or white flashes in between, are necessary if the effect or narrative is to be maintained.

Despite the obvious advantages of faster slide feed, a few projectors still have some version of the old, manual, slide-change system. A sliding carriage is usually mounted between the condenser assemblies and projection lenses of these projectors. This carriage is equipped

with two slide slots. When one slide is inside the gate, the other is outside to the left or right. To change slides, you insert the slide in one of the slots and push the carriage into the gate. When the other slot comes out the opposite side of the projector, you insert a second slide into that slot. When the carriage is moved the other way, the second slide moves into the gate and the first slide is in a position to be removed. A third slide is placed in the position occupied by the first and the process is repeated for the rest of the slide show.

Another type of projector features an ejector button that shoots one slide out as you drop in another. A dexterous projectionist can still change screen images at a reasonable clip with this equipment.

Manual slide projectors have one major advantage . . . price. They often sell for as low as half the price of some automatic versions. One major disadvantage, however, is that they require the constant attention of the operator. This can be quite a burden if your show uses other elements such as remotely triggered strobes, black lights, or other projectors. You'll soon wish for a third hand.

If you plan to implement a large-scale, one projector show, convenience should steer you to either a remote control or an automatic slide projector with a timing device. Using the remote control switch, you can stand several feet away from your projector and still change slides. This changing device can be used with one hand leaving the other free to trigger a second projector or to work the house lights. Some remote control projectors also let you focus and defocus the screen, as well as allow you to reverse the projector.

If your budget is large enough, you may want to use a fully-automatic slide projector with an automatic focusing device, remote control, and timer. Just set its timer at a certain rate of slide change. Then, if you choose, you can ignore the projector until the last slide is being shown, or pick up the remote control and change some slides a bit sooner. Or you can throw the slide out of focus for an amorphous effect. If your automatic projector uses a carousel type-tray, you can leave the projector unattended for a long period of time since the complete series of slides will repeat again and again. This most modern of slide projectors offers the optimum combination of convenience and control.

One problem often encountered in a projection show is that you will be burning out bulbs at a faster than normal rate. The bulb life in the average 35mm projector is usually between 25 to 40 hours. Continually switching a projector on and off will definitely reduce bulb life. Some of the better, although high-priced projectors, have hi-low switches that allow you to run the projectors at a lower lamp intensity. Using one of these projectors with the switch in the low intensity position will help to extend the lamp life.

For those who don't have this type of projector, there are still ways of getting longer lamp life. One method is to use "black slides." These are merely opaque slides, made of cardboard or a similar material, that are inserted into the slide magazine in spots where you don't want a slide projected. A more efficient method to extend lamp life is to hook up your projector to an electronic dimmer. This allows you to run the projector at a low intensity and to fade the slide to darkness. A panel of dimmers can be set up to control many projectors at one time.

There are also "programmers" that dim lamps with outboarded controls, but we'll cover that topic in the section on slides.

Figure 1.

MOUNTING A DIMMER IN A PROJECTOR

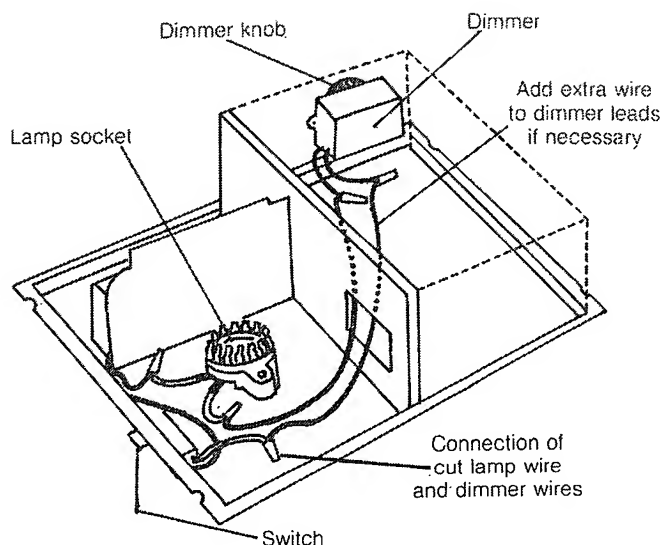
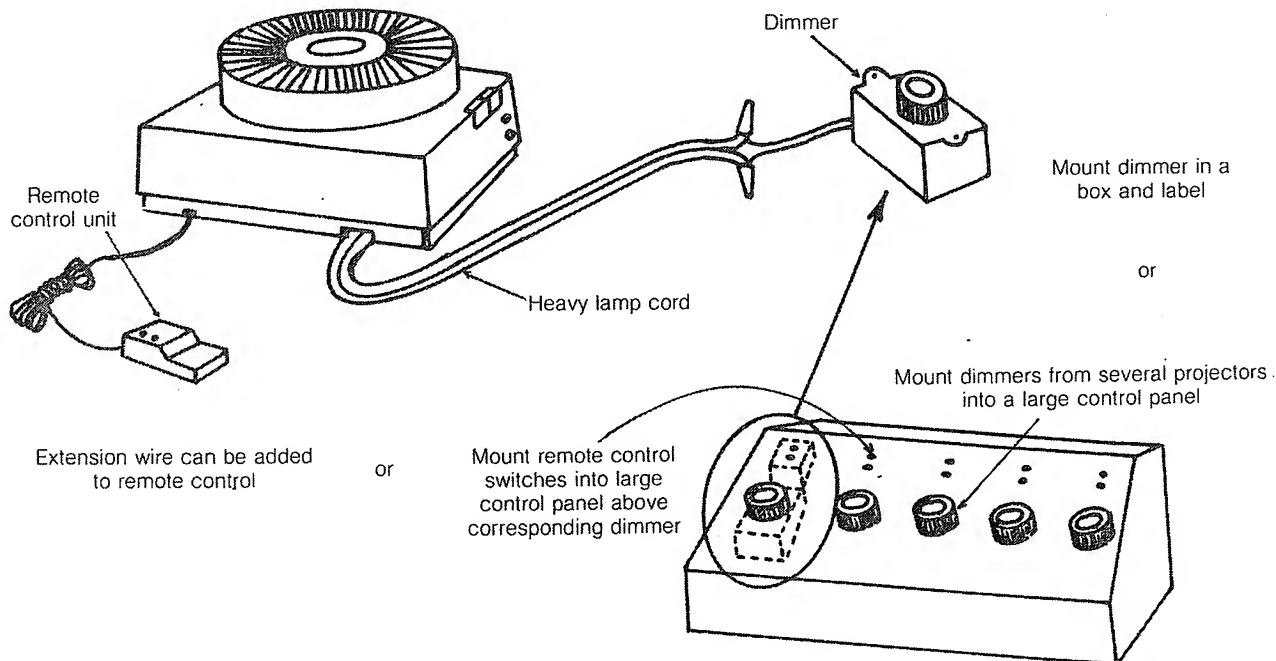


Figure 2.



THE SLIDE MAGAZINE

For remote control of real value, you should use a slide magazine or drum which holds a fairly large number of slides. Otherwise, the convenience offered by automatic slide changing will be offset by the need for continuous magazine changing.

Slide drums are available that can hold from 60 to 160 slides. They attach vertically or horizontally to the projector. If you fill the drum with slides and put one extra in the gate of the projector, you can avoid the white flash each go-round. Keep several drums full of slides to avoid the time-consuming refilling process. Straight magazines that hold from 40 to 60 slides are also available.

For elaborate multi-image shows, the Kodak Universal slide tray is best. It holds 80 slides of any mount. If you want the greatest dependability, your slides should be mounted in plastic and glass frames, such as those manufactured by Wess plastics.

SPECIAL EFFECT PROJECTORS WITH ROTARY DISCS

Most major 500-watt projectors use a magazine to hold and feed slides into the slide gate. The slide magazines are either horizontally or vertically mounted. The slide gate is usually narrow and fairly inaccessible. Therefore, use of these projectors with special effect discs, so valuable to light shows, is prevented because the projectors just won't accommodate special-effect discs, except for "coloring" in front of the lens.

Edmund Scientific, however, sells special effects projectors which will accommodate rotary discs for special effects. Some also incorporate bolts for mounting motors to keep the effects wheels spinning continuously. There's even one Edmund projector which has motors built into the slot to keep two wheels turning. Other kinds are also available at 2 to 5 times the price.

Use As A Regular 35mm Projector

For anyone looking for an exceptional bargain in a 35mm projector, this rotary-disc type is the answer. Its 3" focal length projection lens provides bright and large screen images at short projection distances. Some people actually prefer the 12-slide rotary disc because they can change subjects quickly if needed. Also, it's easy to preview the slides on the holder.

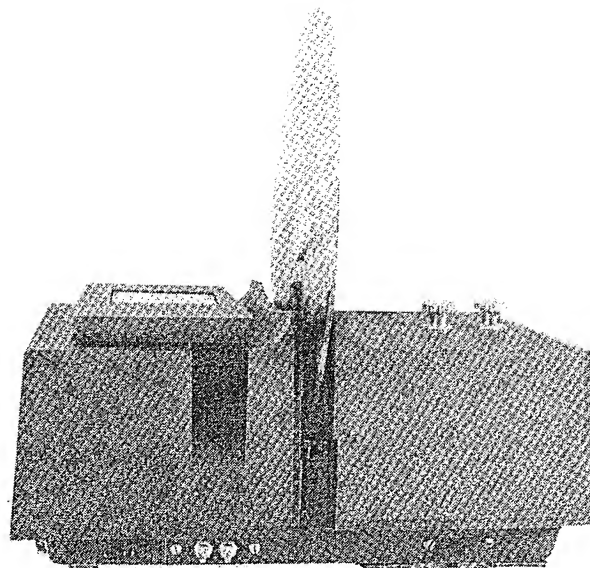
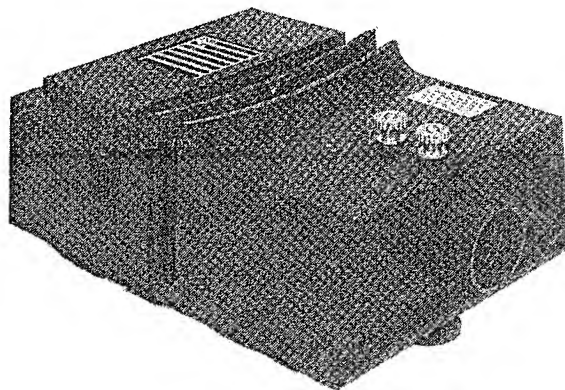
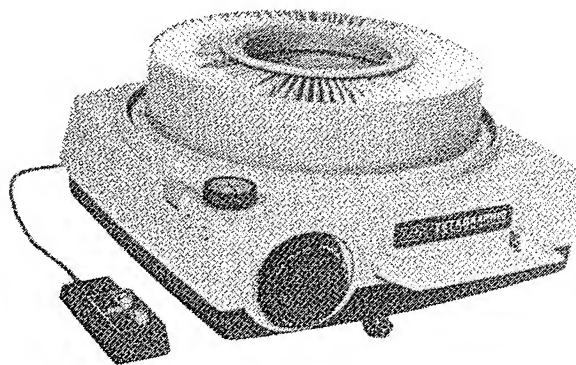
If you want to project many regular slides in a light show, the standard higher-priced projectors are more practical. For home light shows and for most unique lighting effects, there is nothing that compares with this versatile, rotary-disc projector.

The Edmund Visual Effects Projector

The Edmund Visual Effects Projector was specially designed for versatility. Use it in light shows as a spotlight, as a regular 35mm projector, and more. This useful unit is similar to the above 35mm projector, but it has two special built-in bolts. These bolts allow you to

mount color, polarizing, and other special-effect discs, right on the projector. It also includes three special aperture plates that allow you to use the projector as a spotlight by regulating the light show success is its readily-accessible, wide gate. This gate is large enough to accommodate motor driven discs, color wheels, pieces of patterned plastic, etc.

A professional model, with 2 A/C accessory receptacles, is also available.



THE EDMUND 2-WHEEL VISUAL EFFECTS PROJECTOR

This projector incorporates an internal two-motor, rim-drive system which rotates your wheels directly in the gate.

Like other 35mm projectors, the Edmund Projectors will handle 35mm, Instamatic®, and other slides in 2"x2" cardboard or plastic slide mounts. To extend its applications, special design features have been included, allowing it to be used for a wide variety of visual effects.

All Edmund Projectors feature a 500w fan-cooled light source, high resolution f/3.5, 3-in. focal length anastigmatic projection lens and efficient condenser system. There is also a 3-position switch for separate controls of lamp and fan and a detachable line cord fitting neatly into the self-storing cord compartment. A set of 3 aperture plates is included to allow spotlight use. Nuts, bolts, and built-in bracket studs are provided to allow easy attachment of accessories.

Change Wheels . . . Change Motors

The Edmund Projector is versatile and easy to use. You can change three of its basic elements. . . the motor, lens and the wheel to suit the audience or the occasion.

THE BIG PICTURE

Slide projection shows in the home are usually shown on conventional flat screens. Light show producers and more and more commercial projectionists are using ceiling mounted and circular screens. If you use either, you will need to know where to place the projector(s) in relation to the screen. Two factors influence this: (1) the size of the image you want to project and (2) the focal length of the lens. The formula to use to determine this is $D=M+1(F)$ where D = distance from lens to screen, M = magnification or desired magnification and F = focal length of lens.

Example 1. Suppose you want to have a screen image 100 times higher and wider than the slide and your lens has a 3" focal length. How far from the screen should you place your projector?

Solution 1.

$$\begin{aligned} D &= M+1(F) \\ D &= 100+1(3") \\ D &= 101(3") \\ D &= 303"(\text{or } 25\text{ft., } 3\text{ in.}) \end{aligned}$$

Example 2. Suppose your projection area is restricted to a projection distance of 25 feet, 3 inches (303") focal length. What magnification would you get on the screen?

Solution 2.

$$\begin{aligned} D &= M+1(F) \\ \frac{D}{F} &= M+1 \\ \frac{D}{F} - 1 &= M \\ \frac{303"}{3"} - 1 &= M \\ 101 - 1 &= M \\ 100 &= M \end{aligned}$$

Example 3. Suppose you have various focal length projection lenses. Which one should you use if you want 100X magnification and position the projector 25 feet, 3 inches (303") away from the screen?

Solution 3:

$$\begin{aligned} D &= M+1(F) \\ \frac{D}{M+1} &= F \\ \frac{303"}{100+1} &= F \\ \frac{303"}{101} &= F \\ 3" &= F \end{aligned}$$

We have prepared a table on the next page to help you figure the approximate screen image size, the needed focal length of the projection lens, or the lens-to-screen distance required for your projection setup.

Example 1. Suppose you want to project 35mm slides and have positioned your projector (which has a 6" focal length lens) 8 feet from the screen. What size screen image would you have?

Solution 1. Read down the vertical column until you reach 6" F33 L. Go across this column until you reach 8 feet. Then, go up the column until you reach the 35mm slide screen-image size and you'll see that it is 14.1" x 21.5". If you were projecting Instamatics, the screen image would be 17.7" square; super slides, 32.8" square.

Example 2. Suppose you have a projection distance of about 14 ft. and you are projecting Instamatics. You would like a screen image that is about 2 ft. square. What focal length should your projection lens have?

Solution 2. Look at the Instamatic line in the table. Read across until you come to a size of about 2 ft. square (23.6"). Then read down that column until you come to a projection distance close to 14 ft. In this example you find exactly 14 ft. listed. This appears in the 8" F.L. line and, therefore, your lens should have an 8" F.L.

Example 3. Suppose you have a 6" F.L. lens and your projection distance is about 25 ft. You want to project 35mm slides. What will be the approximate size of your screen image?

Solution 3. Read across the 6" F.L. line until you reach a listing that's close to 25 ft. (25 ft. 6"). Go up that column to the 35mm slide line and you'll see that your screen image will be approximately 47.2" x 70.5"

Many manufacturers make available a wide selection of projection lenses of different focal lengths. This allows you to use one projector to project a variety of different slide sizes at different projection distances.

Low Budget Theater and Stage Lighting

If you don't want to spend a lot of money for expensive lighting equipment, your 35mm projector can save the

expense. It can be put to additional uses and even make an excellent spotlight.

Aperture plates can control the size of your projector's light beam so that it covers one performer, a certain area, or a whole portion of the stage. An adjustable aperture plate can be made by using an iris diaphragm.

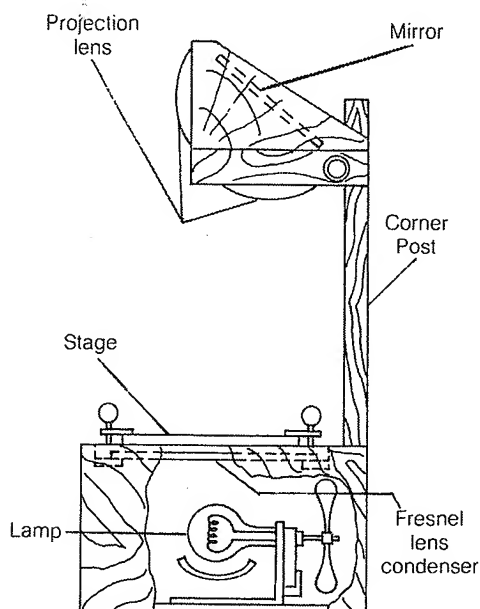
You can easily color a projector spotlight by placing color filters in slide mounts and by projecting these. To change colors, merely change slides.

If you have trouble fitting the color slide and aperture plate both in the projector, you can eliminate the color slide and either hold color filters in front of the projection lens or place a color wheel in front of it. The color wheel probably should have a large variety of colored sections and be operated manually. A motorized color wheel automatically changes colors. See page 23 for more on spotlighting.

APPROXIMATE MAGNIFICATION		6X	8X	10X	15X	20X	25X	30X	50X	100X	125X	150X	175X	200X
Image size of 35mm slides (.944" x 1.41" at 1X)		5.6"x 8.4"	7.5"x 11.2"	9.4"x 14.1"	14.1"x 21.5"	18.8"x 28.2"	23.6"x 35.2"	28.3"x 42.3"	47.2"x 70.5"	94.3"x 141"	118"x 176"	141"x 211"	165"x 246"	188"x 282"
Image size of Instamatic slides (1.18" sq. at 1X)		7.0" sq.	9.4" sq.	11.8" sq.	17.7" sq.	23.6" sq.	29.5" sq.	35.4" sq.	59.0" sq.	118" sq.	147" sq.	177" sq.	206.5" sq.	236" sq.
Image size of super slides (1½ sq. at 1X)		9" sq.	12" sq.	15" sq.	22.5" sq.	30" sq.	37.5" sq.	45" sq.	75" sq.	150" sq.	187.5" sq.	225" sq.	262.5" sq.	300" sq.
Lens to screen distance for lens with focal length of	F.L.													
	2½"	1' 5.5"	1' 10.5"	2' 3.5"	3' 4"	4' 4.5"	5' 5"	6' 5.5"	10' 7.5"	21' 0.5"	26' 3"	31' 5"	36' 6"	41' 8"
	3"	1' 9"	2' 3"	2' 9"	4"	5' 3"	6' 6"	7' 9"	12' 9"	25' 3"	31' 6"	37' 9"	44'	50' 3"
	4"	2' 4"	3"	3' 8"	5' 4"	7'	8' 8"	10' 4"	17'	33' 8"	42'	50' 4"	58' 8"	67'
	5"	2' 11"	3' 9"	4' 7"	6' 8"	8' 9"	10' 10"	12' 11"	21' 3"	42' 1"	52' 6"	62' 11"	73' 4"	83' 9"
	6"	3' 6"	4' 6"	5' 6"	8"	10' 6"	13'	15' 6"	25' 6"	50' 6"	63'	75' 6"	88'	100' 6"
	7"	4' 11"	5' 3"	6' 5"	9' 4"	12' 3"	15' 2"	18' 1"	29' 9"	58' 11"	73' 6"	88' 1"	102' 8"	117' 3"
	8"	4' 8"	6'	7' 4"	10' 8"	14'	17' 4"	20' 8"	34'	67' 4"	84'	100' 8"	117' 4"	134'
	10"	5' 10"	7' 6"	9' 2"	13' 4"	17' 6"	21' 8"	25' 10"	42' 6"	84' 2"	105'	125' 10"	146' 8"	167' 6"

OVERHEAD PROJECTORS AND THEIR USES

An overhead projector has several things in common with a 35mm projector. In both, light from a projection lamp passes through a condensing system, an object to be projected, a projection lens, and finally onto the screen.



The condensing system of an overhead projector is different from its 35mm counterpart. The overhead's condenser is a specially designed version called a Fresnel lens. This thin, flat lens has a series of concentric, stepped grooves that bend light. These grooves and their light bending ability permit large diameter Fresnel lenses to be thin and lightweight. Normal condenser lenses of similar diameter have to be thick to do the same job. Their thickness makes them heavy, unwieldy, and prone to cracking.

Unlike a 35mm projector's condenser, the Fresnel condenser is horizontally mounted. A protective glass plate is positioned over the Fresnel. This is the projector's stage on which various objects are placed for projection. This horizontal stage supports the item to be projected and provides the versatility inherent in overhead projection.

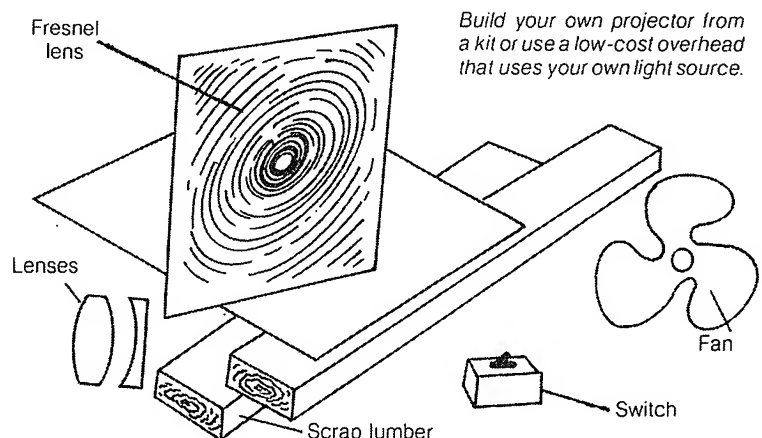
Your budget and the types of effects you want to generate should dictate your selection of an overhead projector. The following are features to look for:

Overheads with quartz-iodine or quartz-bromine (halogen) projection lamps are far superior to those with incandescent lamps which are not as bright watt for watt. Brightness is essential for most applications and some effects utilize materials that reduce the output of an incandescent lamp: for instance, polarizing materials reduce the intensity of an incandescent lamp almost twice as much as they do a halogen lamp's wattage.

Plastic Fresnel lenses are better than glass lenses. Glass weighs more and allows less light through to your projection area.

Some overhead projectors are designed in such a way that it is difficult to focus them without getting your hand or arm in the way. The most desirable ones have the lens/mirror system on a swivel-post so that you can change the transparency from either side. The "stage area" on these is more accessible for acetate rolls and larger clock crystals also.

Needless to say, an overhead with a 10" x 10" stage is better than one with a 5" x 5" stage; it gives you four times the working area and a larger image at a shorter distance, but your budget will have to determine which kind you buy. There are many good ones on the market, and there are also kits available from which you can build your own from scratch or adapt a 35 mm projector if you already own one.



EFFECTS WITH AN OVERHEAD

Many effects and techniques employed on an overhead projector are described in Chapter 14. Here are a few that aren't.

Abstract Color Plus Moiré

Color coupled with moiré patterns can provide an unusual and fascinating effect.

The least complicated method is to attach a motorized color wheel to the projector's post so that the wheel rotates close to, and underneath, the projection lens. Or, it can be attached to the lens housing and spun in front of the lens. Place two similar moiré patterns on the stage. While the color wheel spins and changes the color of the light beam, move one moiré over the other in time with music or in any random manner. The interesting patterns of the moirés and the changing colors create wild, exciting patterns.

The color wheel should be attached in such a way that it can be swung out of the light beam every once in a while. This takes the color out of the beam. The projected result is a pattern of harsh, wavy, black lines that jolt the viewers who are accustomed to the changing colors.

Another method is to automate the process by having one of the moiré patterns continually moving on top of the other moiré. This can be done by friction drive or by hooking an eccentric arm to a motor's shaft and attaching a post to the upper moiré pattern. The post is then inserted through a hole in the eccentric arm.

If you have more than one overhead, you can have more colors at one time. Attach color wheels to each projector. Each color wheel should be different. A good set-up is to have three or more projectors, all aimed at approximately the same spot. One projector has the moving moirés and a standard 6-segment color wheel. The others should each have a color wheel with two or three shades of the same color . . . one with greens, another with reds, and so on. Changing abstract color and moving moirés can be a very interesting effect. You could have motors with different speeds on the color wheels. Dimmers may be mounted in the projectors to allow adjustment of their lamp intensities and, hence, the brightness of their images on the screen. They also allow cross fades from one image into another. See Chapter 16 for instructions on how to wire and mount dimmers. 35mm projectors with color wheels can be used in place of the overheads without moirés.

Morphous Effects

There is something about the sight of sharp, bright colored, randomly distributed shapes on a screen that fills us with a titillating sense of disturbance. The edges are jagged. The colors are cool. The harsh, straight lines evoke an angry feeling which is the essence of the morphous effect and which you can create with one overhead projector and a minimum of effort.

"Morphous" is a Greek word meaning "shapely" and, in special effects lighting, "morphous" effects have definite edges to them.

"Morphous" paintings are done with fragments of trans-

parent, colored filter materials. Cut the color filter sheets into a variety of shapes. Sharp-angled fragments, triangles, rectangles and shattered shapes are easiest with which to work. Use a variety of colors. Lay the sections, one at a time, on the stage of the projector. Watch the abstract painting appear and change shapes on the screen. You might let some of the pieces of material overlap for darker shades. You can change color tones, if you wish, by placing a rotating color wheel in front of the projector.

For still more interesting effects, use a transparent moiré pattern as a picture base. Place sections of the colored filter material on top of the moiré. Old, discarded X-rays can also be used. Or try large photographic negatives. These can bring a familiar element of reality to your line of abstraction.

Keep in mind that stages of most overhead projectors are either 5" or 10" square. Sheets of moiré patterns, X-rays or negatives should be at least that big.

Amorphous Effects

Amorphous (without definite form or shape) screen images can create interesting effects in your light show. These effects are the direct opposite of the rigid, angular morphous effect. Hazy, defocused, mind-extending images that have movement are what we're after. These can be achieved in a number of ways.

The simplest method is to defocus the projector and merely move a transparency back and forth. Focusing and defocusing the projector creates movement also. Add one stationary and one moving moiré and look at the result.

Wet Shows

A "wet" show is one that incorporates a projection of moving, colored liquids. They can be achieved with special effects projectors or with overheads.

To project a wet show with an overhead:

Spread a large plastic tablecloth under your projection table to protect the floor from stains.

Place a transparent acetate sheet over the stage of the projector. This protects it from scratching or being stained.

You need many clear glass containers . . . we prefer clock crystals, but you can also use Petri dishes, shallow glass dishes (preferably Pyrex®), or for a limited number of effects, you can use just the transparent acetate sheet. You'll need many containers because the colors, chemicals, oils, etc. will react together and "muddy the waters" making changes a necessity. In this section, we'll assume that you are using clock crystals.

You'll need plastic buckets in which you will dump the used projection solutions, suspensions, or gels.

The projection materials used depend upon the effects you want to achieve. Here are some that are commonly used: water, food coloring, ink, mineral oil, glycerin, alcohol, a clear viscous shampoo, gels, benzene, methyl-ethyl-ketone, carbon tetrachloride, sulphuric acid, methylene dichloride, fruit juice, and so on. You'll have to experiment to find what mixtures cause certain effects.

BE CAREFUL:

Many of these solutions, and others available, can damage your skin, eyes, or lungs. Some are poisonous. Always read the caution notice on the label of any solvent or chemical used. Some solvents should not be inhaled for more than a short time. Always know with what you're working.

Wear protective gloves and old clothes. A laboratory apron is ideal. If you're using dangerous materials, wear protective eye goggles or laboratory glasses. We've never heard of anyone suffering eye damage as a result of a wet show's splashes, but don't you be the first.

You'll need syringes, eye droppers, or squeeze bottles to add solutions and dyes to the clock crystals. We recommend the plastic squeeze bottles that are normally used for catsup and mustard. These are cheap and are commonly available. One squeeze bottle for each different solution makes for easy storage. Be sure to clearly label the squeeze bottles so you know exactly what you have in them.

Some Wet Show Winners

It must be remembered that wet show effects are created by the operator. This is an art which must be learned by experience. The more you experiment, the more proficient you'll become.

In a wet show, a new pattern appears continually. It's nearly impossible to repeat patterns and images exactly. This is part of the wet show appeal. You must learn the type of image you'll obtain by certain techniques, however. This knowledge is gained by experiment and practice. An expert wet show artist knows what kinds of results he will get when he uses different chemicals, dyes, motion, etc. This is especially important when the wet show accompanies music. Some professional combos hire a wet show artist to create effects according to the tempo, volume, and mood of the music. This requires good technique and rehearsals with the group.

There are many wet show effects, too many to describe in this book. The following will give you an idea of what you can do.

The Battle of Colors

Set a large clock crystal or flat-bottomed glass dish on your overhead's stage. Next, half-fill it with water. Using an eye dropper, add a few drops of different colored inks or food coloring to the water. Project the colors as they mix. You'll see the colorful swirl as the colors blend. The darker colors will slowly overcome the lighter ones in a battle of colors which your audience won't forget.

You may want to control the speed at which the colors mix. If so, use syringes instead of eye droppers. Now you can choose a "rate of swirl" to match the mood or music. Squeeze a syringe slowly when slow music is playing. The swirls of color on the screen will develop slowly and gently. Press harder and quicker on the plunger when the music picks up. The colors will swirl faster. You can use several syringes to introduce several streams of color at one time, again, matching the combination to the mood or the music.

The Color Burst

Probably one of the most interesting wet show recipes involves only water and powdered dye. To implement this, first dissolve the powdered dye in water. Use a very strong concentration. Fill a clock crystal with water and place it on your overhead projector's stage. Then add a single drop of mineral oil to the water. The drop of mineral oil will float on the water.

Using an eye dropper, place a small drop of the dye solution on top of the drop of mineral oil. The color will, at first, be imprisoned in the mineral oil drop. It will seem to press against the walls of the drop. Then, when you least expect it, the color will break out of the mineral oil and fill the screen.

You can hurry the color burst along by dropping a single drop of benzene or methyl-ethyl-ketone into the drop of mineral oil.

Islands of Color

Methylene dichloride and carbon tetrachloride are both fairly insoluble in water. If you dissolve a colored ink or dye in both of these and add drops of the solutions to water, you will see island-like amoeboid forms floating across your screen. These colored islands will collide and sometimes mix.

The Effervescent Wet Show

You can agitate the liquid in your wet show simply by blowing into a straw that's dipped into the liquid. But if you drop a grain or two of Alka-Seltzer into the clock crystal, your screen will be covered with activity. You may want to introduce more colored ink into this bubbling witch's brew. The liquid will immediately devour and digest the color.

The Squash Show

This commonly used effect is easy to accomplish. Use two concave containers, one smaller than the other. Place the larger one on the projector's stage and add drops of colored glycerine, mineral oil, shampoo, or whatever you choose. Then, use the smaller container to mash, squash, splash, and spread the drops. This is projected as an action-filled, colorful struggle on the screen.

A Fish in A Wet Show

You may want to add a solid body in motion to some of your wet show's liquid effects. Nothing moves about as easily in water as a fish. Place a small goldfish in a large, flat-bottomed, clear glass dish that is filled with water. Add different colored vegetable dyes to the water. Project the results. The fish will dart about and the screen will show a shadowy form gliding through the color. Add a moiré pattern to the bottom of the dish and the fish will seem to swim over and through the lines on the screen.

The vegetable colors will not harm your fish, but the heat of the projector lights might. So, alternate the fish periodically. Do not expose any one fish for more than three or four minutes. See to it that the dish is large, the glass is thick, and the water is fairly cool at all times.

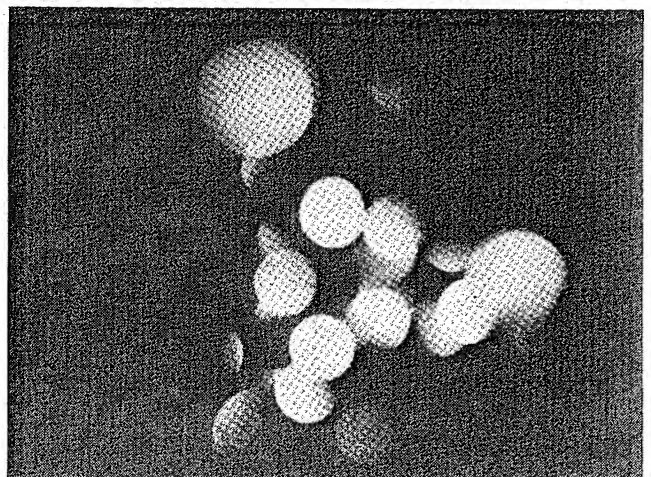
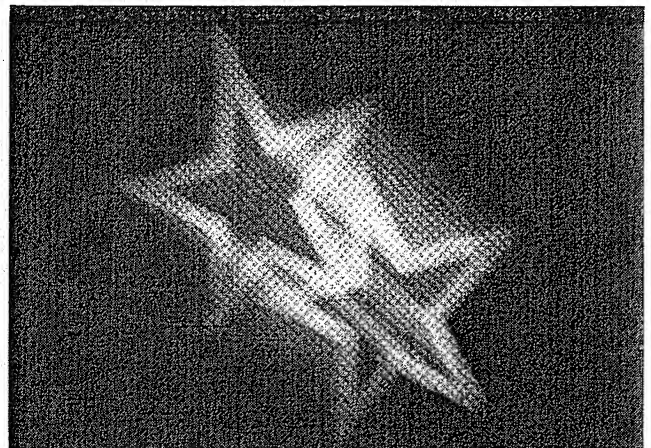
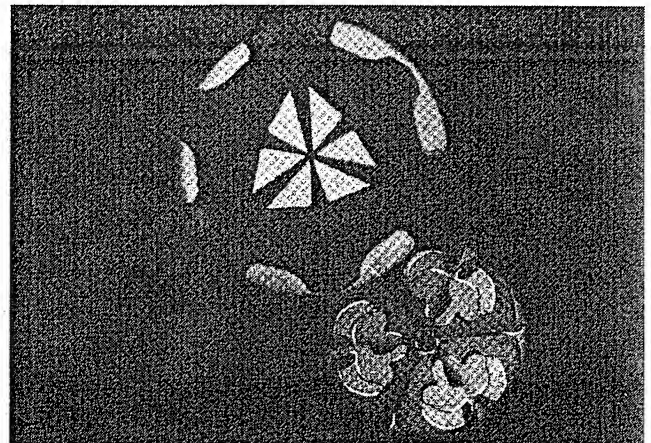
THE ART OF SCULPTING LIGHT

Light projection first became popular in modern theatre and dance in the 1950's and, shortly afterward, experimenting began by the new underground film makers. Extensive use and popularity of lights and light projection techniques came in the late 1950's with the growing California "psychedelic" movement. This new culture began to spread quickly toward the East, bringing with it, the "light show." In a short time the concept of the "light show" was changing and its innovators were discovering fascinating new techniques. Nightclubs and rock groups became interested, hoping light would add new appeal to their presentations. The scene was set . . . America was now ready to give way to such establishments as discotheques and boutiques that used unique lighting to enhance their popularity.

Private businesses, from the corner shoe store to the chain department store, were finding that the "light show" effect could add new life to those dated window displays. Today, the lighting technologies created in the psychedelic movement surround us in all our daily lives. Imaginative young people have made profound progress in the field of lighting, adding excitement to parties, dances, and shows.

In this chapter we discuss the accessories available for use with the Edmund Special Effects projectors described earlier. Many of these wheels can be utilized with other kinds of projectors also by mounting the wheels on a separate stand in front of your projector lens.

The number of visual effects which you can produce with the Edmund Projectors is almost unlimited. You can combine accessories, create new designs, or experiment with almost anything to produce the desired effects. To enable you to become familiar with some techniques for successful lighting, we have assembled an Easy-Reference Chart of our most popular effects and the accessories needed for their construction. Following the chart is a detailed explanation of the step by step assembly of all the effects listed, as well as some helpful hints on visual lighting.



EASY REFERENCE CHART

EFFECT	DESCRIPTION	PAGE	ACCESSORIES NEEDED
			*All effects require brackets and 1 rpm motor
1. Rippling Color with or without lens	Rippling, undulating, floating colors surrounding the audience	14	Rippling Color Accessory Psychedelic Wheel
2. Colored Clouds	Beautiful blending, swirling, colorful clouds	15	Colored Cloud Accessory Colored Window Wheel
3. Starbursts	Beautiful display of intense, fiery, central color, bursting into fire. . . crystalline splinters of delicate hue	16	Colored Cloud Accessory Striped Wheel
4. Fire Effect	A fantastic blend of canary & red colors creating a sparkling, wispy, fire effect	16	Colored Cloud Accessory Hexidoscope Accessory Extra Rubber Eyeguard Glass Wheels 12 rpm Motor
5. Swirling Cycloids	Colorful dots that explode and drift	18	Colored Cloud Accessory Hexidoscope Accessory 12 rpm Motor Colored Window Wheel Opaque Window Wheel
6. Colliding Planets	Colored spheres glide by, floating in space	19	Hexidoscope Accessory Colored Window Wheel
7. Whirling Rods	Tumbling, drifting spherical rods that spin across the screen	20	Colored Window Wheel Lenticular Wheel 12 rpm Motor
8. Music Notes	Hundreds of musical notes that drift and flow across the screen	20	Music Note Wheel
9. 3-Dimensional Effect	Moving 3-D geometrics	20	3-D Wheel Lenticular Wheel 12 rpm Motor
10. Kaleidoscope	Everchanging kaleidoscope images of bright, colorful, circles, polygons, etc	21	Kaleidoscope Lens Psychedelic Wheel
11. Special Wet Kaleidoscope	Kaleidoscope images of bubbles oozing, expanding, and slipping between colored plastic pieces	21	Bubble Wheel Kaleidoscope Lens
12. Moiré	Mind-boggling moiré effects as overlay or in 3-D	22	Hexidoscope Kaleidoscope Lenticular Wheel 12 rpm Motor Moiré Wheel
13. Polarization	Dancing, moving images.	22	30 rpm Motor Polarizing Wheel Glass Disc
14. Spotlight	Versatile theater spotlight	23	Adjustable Diaphragm
15. Logo/Name	Design "grows" in spokes from center screen	24	Plain glass wheel, stencil, Hexidoscope 4 rpm, Psychedelic Wheel

Figure 3.

INDICATES HOW WHEEL IS ATTACHED TO MOTOR AND PROJECTOR

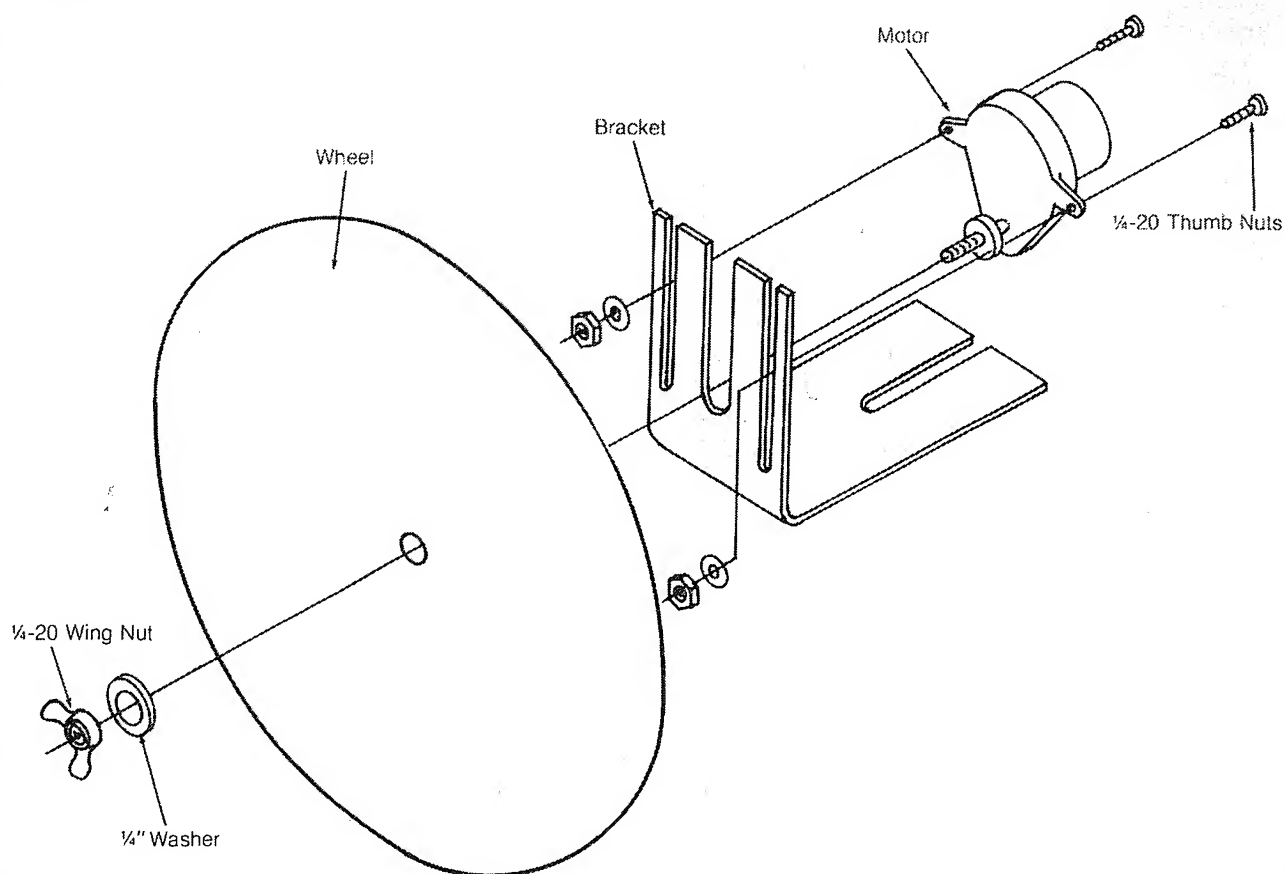
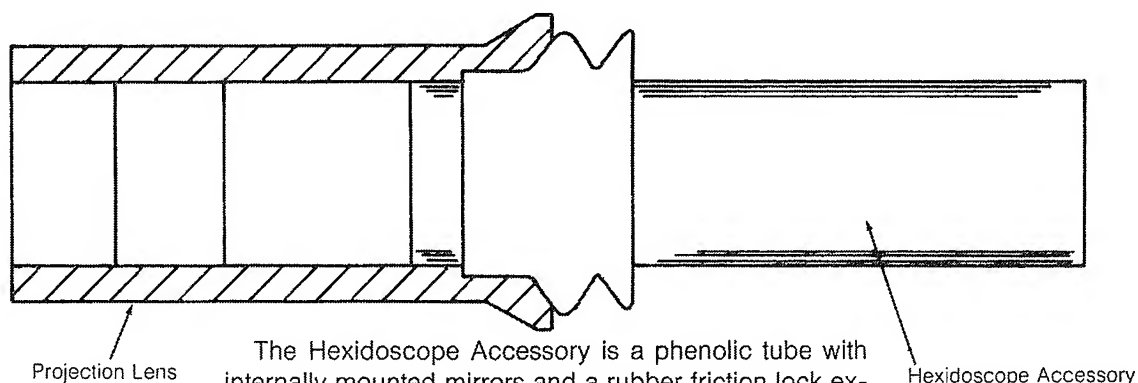
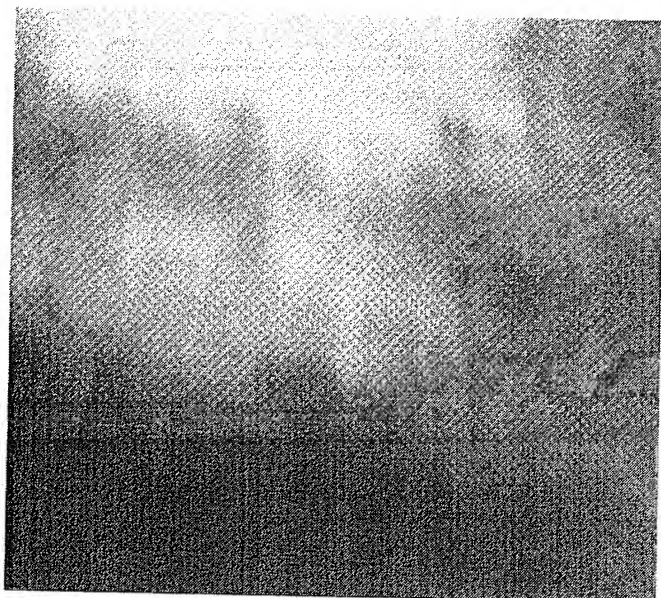


Figure 4.



The Hexidoscope Accessory is a phenolic tube with internally mounted mirrors and a rubber friction lock externally mounted. The lock holds the accessory firmly in the forward part of the projection lens barrel.

To use the Hexidoscope Accessory, proceed as follows: twist and push the Hexidoscope Accessory into the projection lens barrel with one hand while holding the barrel with the other hand.



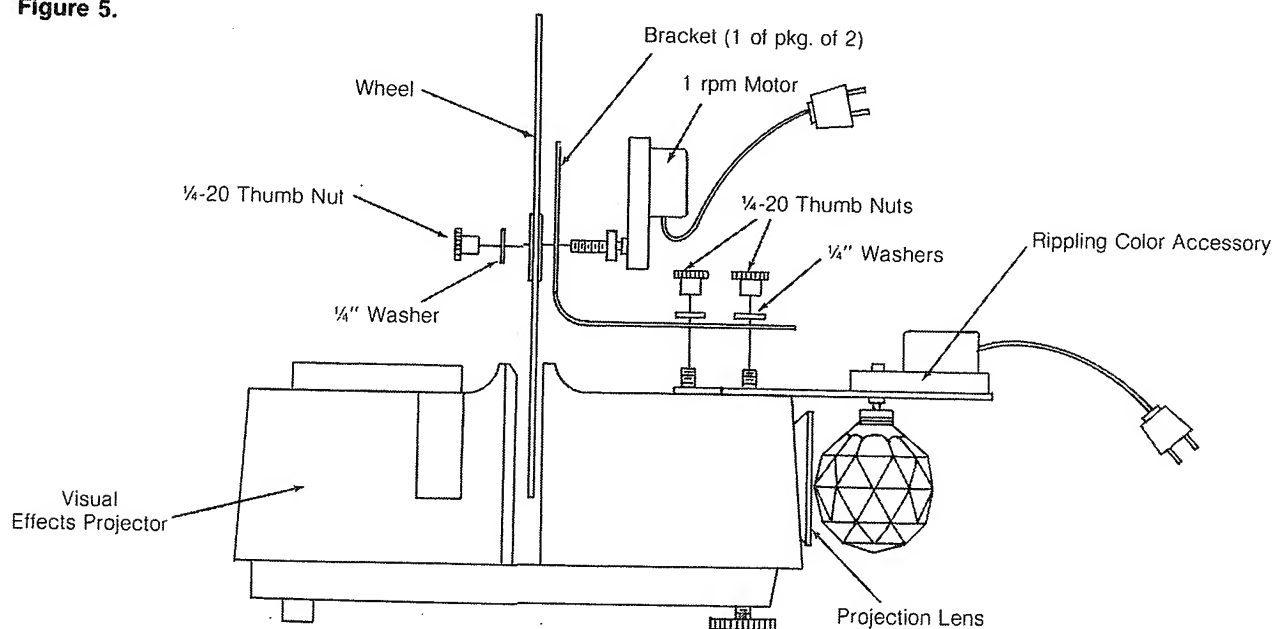
RIPPLING COLOR

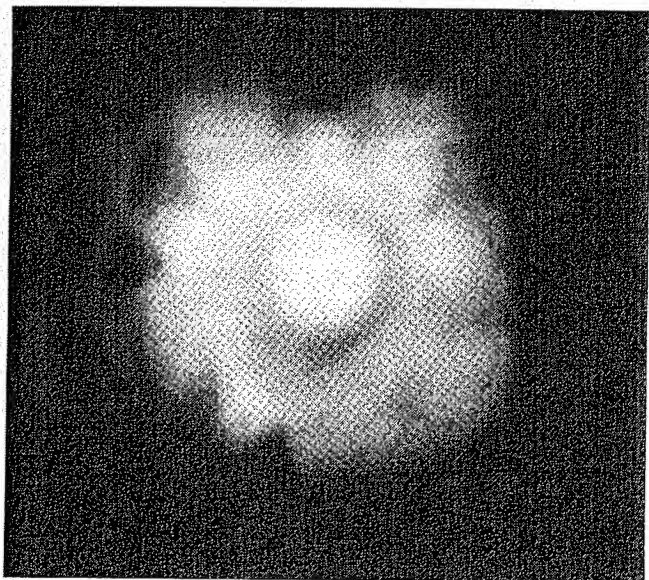
This effect can be used with or without projection lens for a varying image.

Installation and Use:

1. Mount the 1 rpm motor to one bracket using the No. 6 hardware provided. Slots allow vertical adjustment of the motor and wheel which will be attached to it.
2. Select a wheel and mount it on the motor hub with a No. 1/4-20 thumb nut and washer.
3. The wheel, motor and bracket form an assembly which is mounted as a unit on top of the projector body with two No. 1/4-20 thumb nuts and washers. You may find that the wheel binds in the bottom of the gate area or is too high for complete illumination. In either case, adjust the height as described in 1.
4. Slip the Rippling Color Bracket onto the studs on top of the projector body over the motor bracket and under the No. 1/4-20 nuts and washers as shown in figure 5.
5. You may or may not wish to use the projector lens barrel. In either case, move the ball close to either the front end of the projector lens barrel or close to the opening in the projector housing to create whichever version of the effect you prefer. Have ball as close to the lens or opening in the projector as possible, without the ball touching the lens or projector.

Figure 5.





COLORED CLOUDS

Beautiful blending, swirling colorful clouds.

Installation and Use

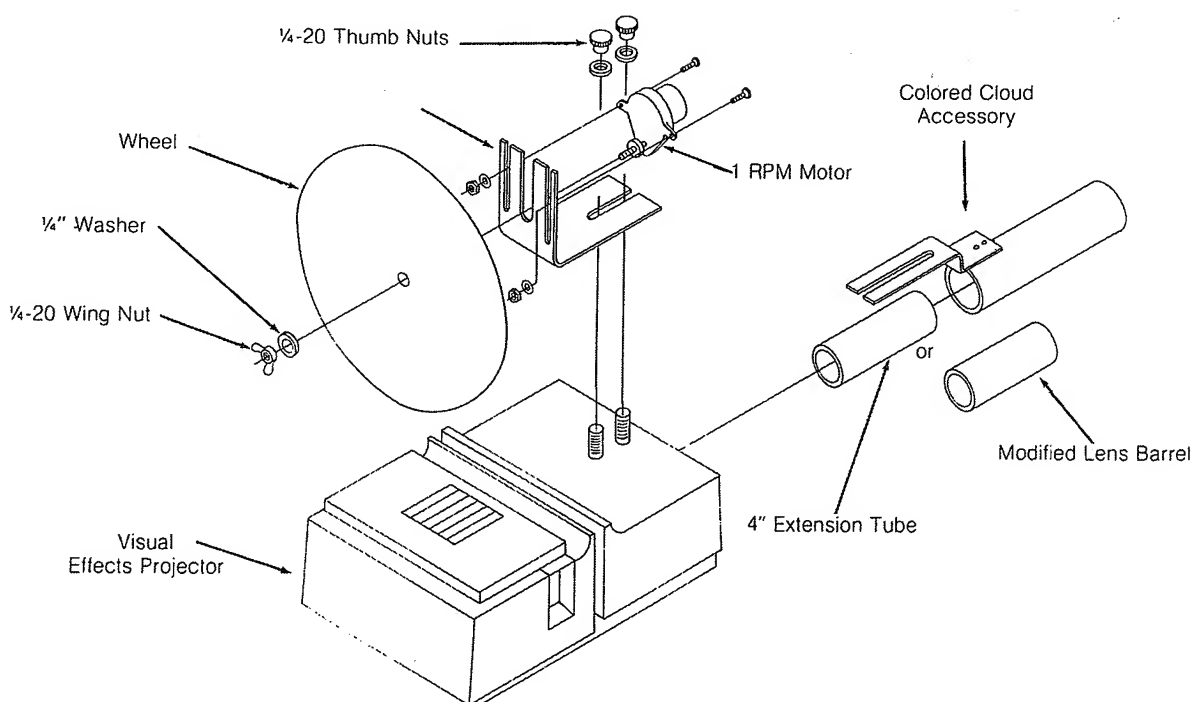
The general arrangement is shown in figure 6. Mount the 1 rpm motor to the bracket as shown using the No. 6 hardware provided. The slots allow vertical adjustment of the motor and the wheel which will be attached to it. Select one of the wheels and attach it to the motor hub with the No. 1/4-20 wing nut and washer. The wheel, motor, and bracket form an assembly which is mounted as a unit on top of the projector body studs with the two No. 1/4-20 thumb nuts and washers. You may find that the wheel binds in the bottom of the slide gate area or is too high for complete illumination from the lamp. In either case, adjust the height as described above.

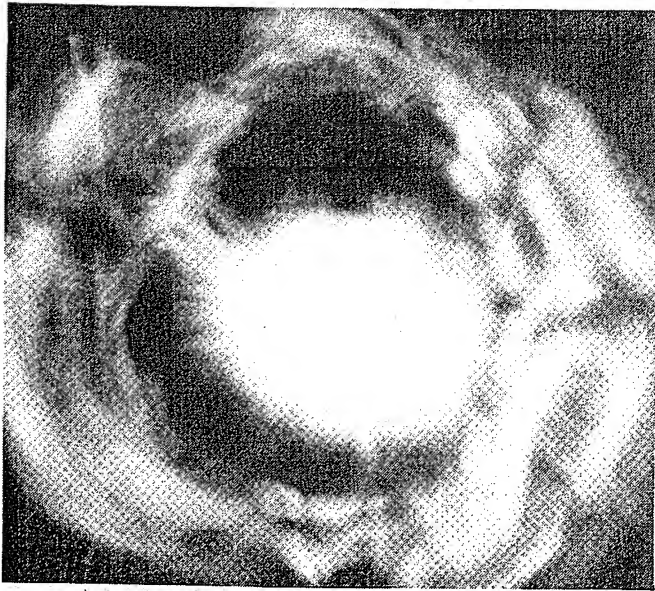
The Colored Cloud Accessory has its own support bracket which holds it onto the projector body.

First insert either the 4" extension tube or the forward end of the modified projector lens barrel into the rear portion of the Colored Cloud Accessory about half an inch. It is suggested that the barrel be removed from the projector to accomplish this. Slip the Colored Cloud Accessory Support Bracket over the motor bracket and under the No. 1/4-20 nuts and washers while guiding the cylindrical portion of the modified projection lens barrel, (4" extension plus Colored Cloud Accessory or modified lens barrel plus Colored Cloud Accessory) into the projected barrel housing. Focusing is accomplished by moving the combined projection lens in or out and then locking the No. 1/4-20 nuts when the satisfactory adjustment has been reached.

Note: Alternate image wheels may be either purchased or made up by the user.

Figure 6.

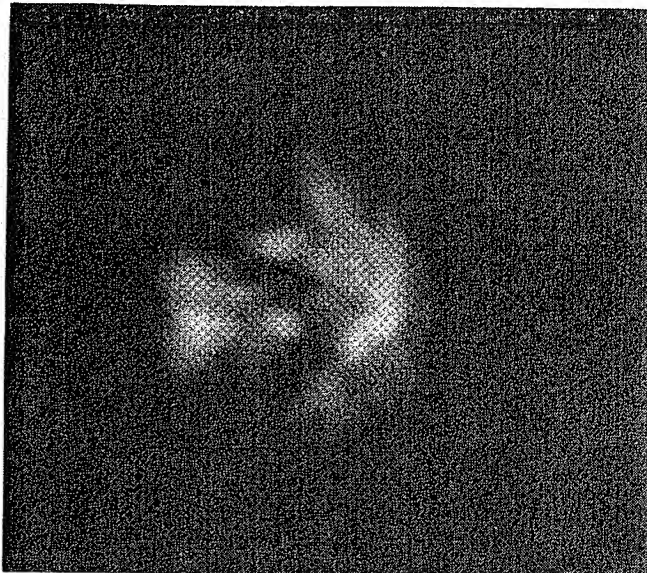




STARBURST

Beautiful display of intense, fiery, central color bursting into fire . . . crystalline splinters of delicate hues.

This exciting effect is produced in the same manner as colored clouds using a different wheel. In place of the striped wheel, the Colored Window Wheel is set into the projector gate.



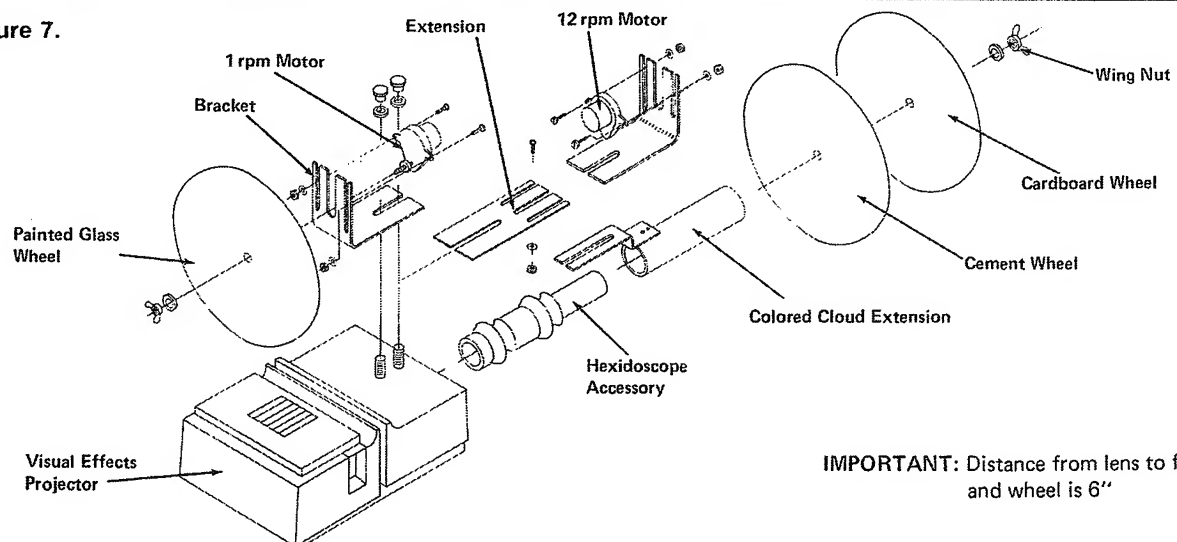
FIRE EFFECT

The lens system is a combination of the "Colored Cloud" accessory, the "Hexidoscope" accessory, and a rubber eyeguard.

Equipment Needed

1. Visual Effects Projector
2. Lens and Extension from Colored Cloud Accessory
3. Hexidoscope Accessory
4. Extra Rubber Eyeguard
5. 9" Glass Wheels
6. Transparent Paint: Canary & Cardinal Rose
7. 1 rpm Motor
8. 12 rpm Motor
9. Duco Household Cement
10. 9" Cardboard Wheel (you make)
11. Brackets

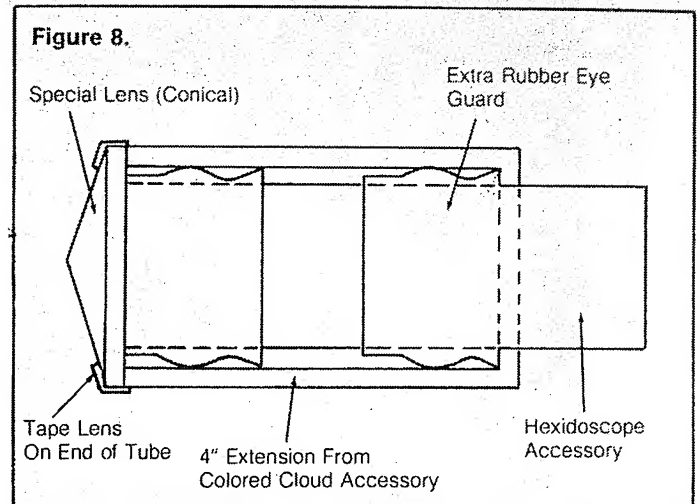
Figure 7.



IMPORTANT: Distance from lens to front motor and wheel is 6"

DIRECTIONS FOR COMBINING THE UNITS

1. Lift the split retaining ring from the Colored Cloud unit and remove the special conical lens.
2. Slip the rubber eyeguard onto the Hexidoscope unit and then into a 4" extension tube.
3. Tape the special lens on the end of the tube as in Fig. 8. Make sure the tape comes over the lens about 1/8" and down on the side of the tube at least 1/4". If you intend to point your projector down at the screen, put additional tape around the tube to make a tight fit in the projector



MOTORS AND WHEELS

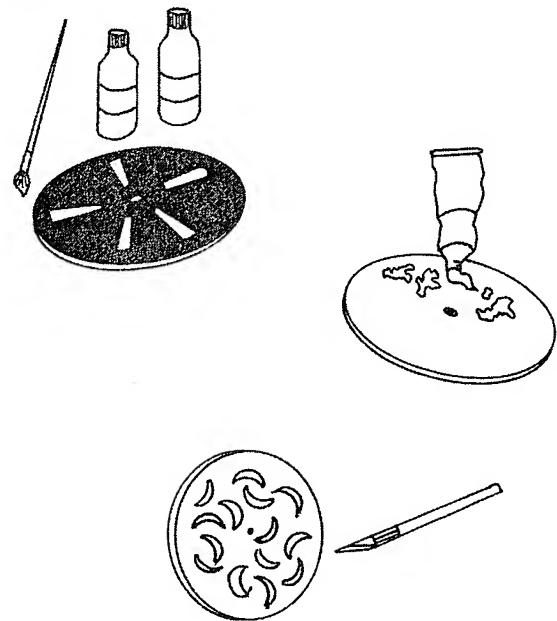
Start by painting the fire wheel cardinal red with a few streaks of yellow. Very little yellow is used . . . see drawing. Be sure to use a glass wheel. This wheel is turned by a 1 rpm motor in the gate of the projector.

Dab Duco® household cement on the 9" glass wheel. The entire wheel does not have to be covered . . . small spaces are permissible.

Select a piece of fairly rigid cardboard and draw a 9" circle with a compass. With a razor blade or razorknife, cut quarter-moons about 2-1/2" long. Cut or punch a 1/4" diameter hole in the center. See Fig. 9.

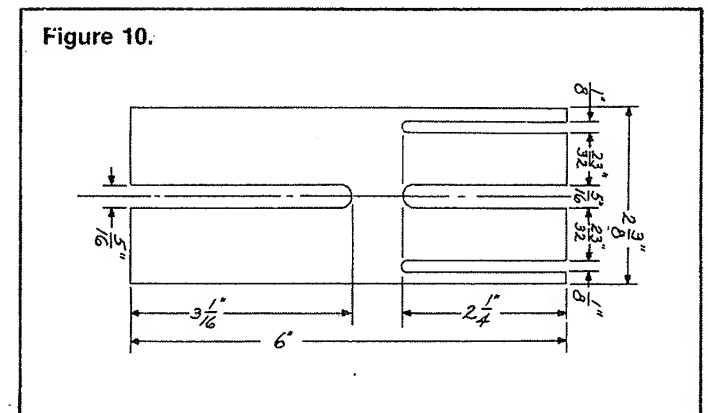
Place the Duco® cement and cardboard wheels on the shaft of a 12 rpm motor. Wheels should be approximately 6" away from the projection lens.

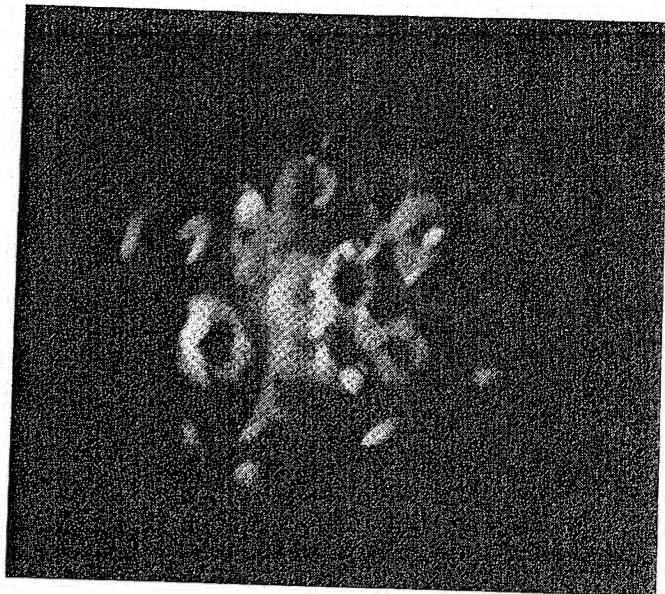
Figure 9.



METAL EXTENSION

To position the motor 6" away from the lens an extension is needed. Either you can make one yourself out of 1/16" thick aluminum or buy one. Fig. 10 gives dimensions for making the extension yourself.





SWIRLING CYCLOIDS EFFECT

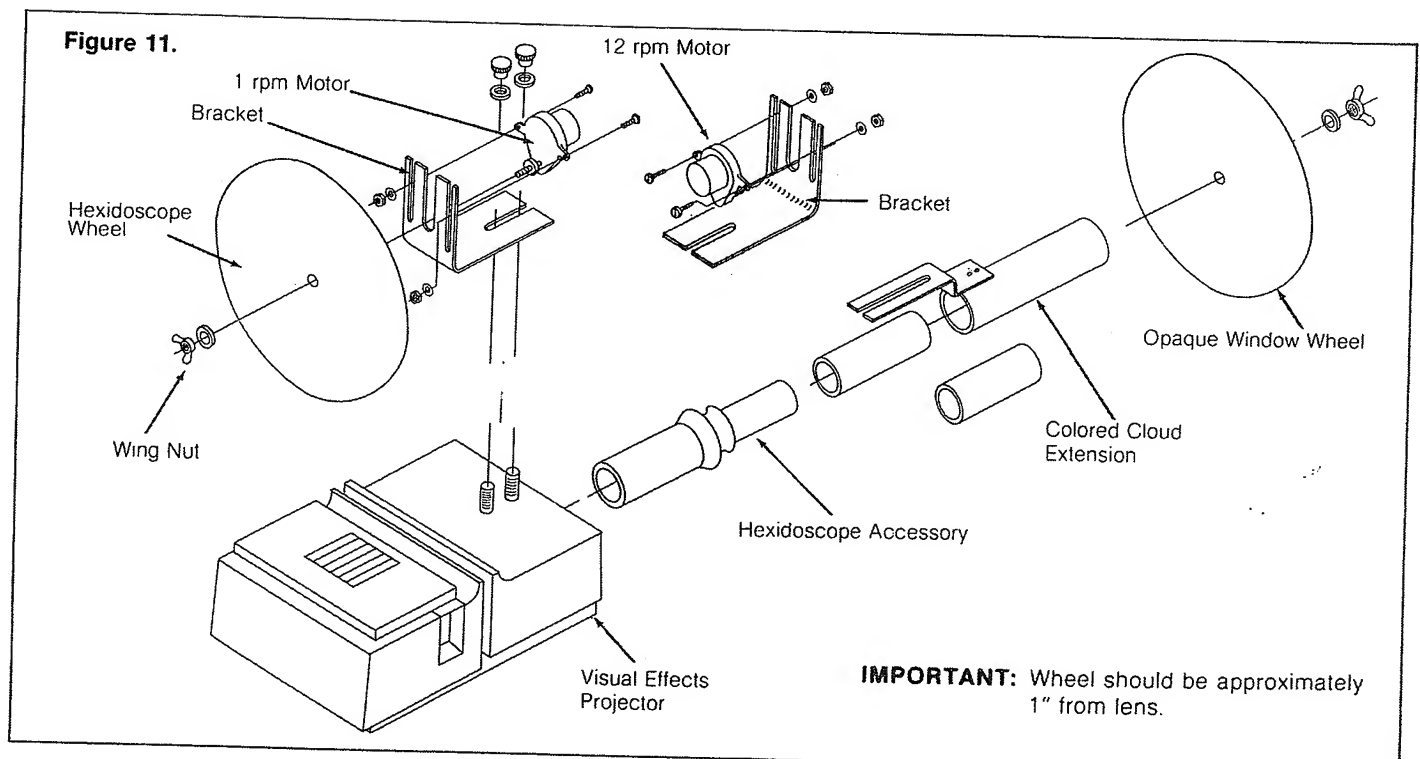
"Acid Rockets Effect"

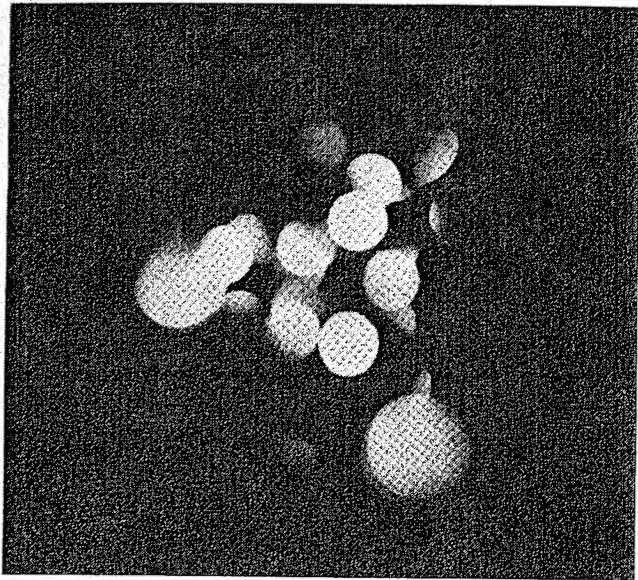
Colorful dots that explode and then drift.

This effect requires the combining of various accessory units exactly as described in the FIRE EFFECT (page 16). The wheels, of course, are changed to alter the effect as shown in the diagram below.

Equipment Needed

1. Visual Effects Projector
2. Lens & Extension From Colored Cloud Accessory
3. Hexidoscope Accessory
4. 1 rpm Motor
5. 12 rpm Motor
6. Hexidoscope Wheel
7. Opaque Wheel With Clear Round Windows (or cut your own from cardboard)
8. Brackets (pkg. of 2)
9. Rubber Eyeguard





COLLIDING PLANETS

Colored spheres glide by floating in space, sometimes colliding, sometimes sliding past each other, contrasting and blending hues in continuous semi-kaleidoscope array...

Assembly Directions

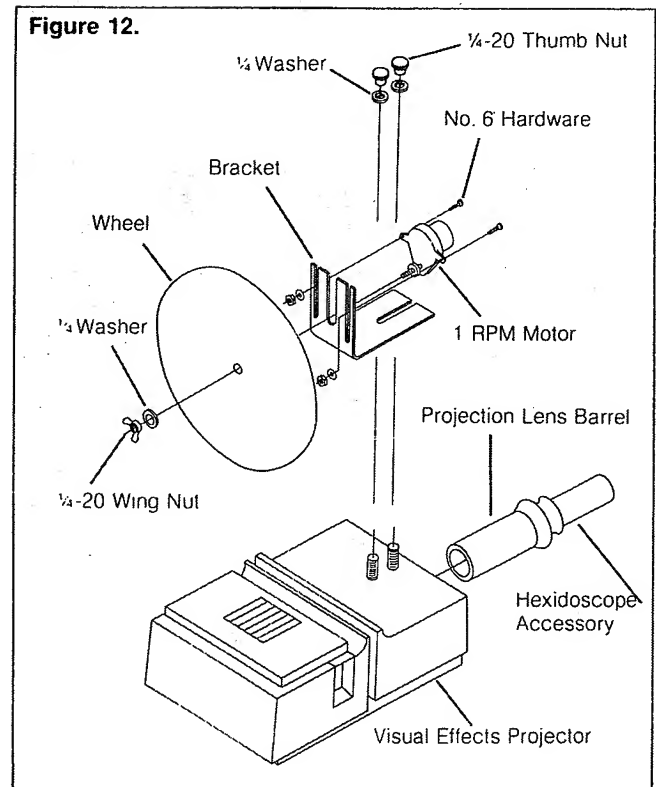
Mount the 1 rpm motor to the bracket as shown using the no. 6 hardware provided. The slots allow vertical adjustment of the motor and the wheel which will be attached to it.

Select the colored window wheel and attach it to the motor hub with the 1/4-20 thumb nut and washer.

The wheel, motor and bracket form an assembly which is mounted as a unit on top of the projector body with the two 1/4-20 nuts and washers. You may find that the wheel binds in the bottom of the gate area or is too high for the illumination by the lamp. In either case, adjust the height as described above.

Focusing is accomplished by moving the combined lens barrel and Hexidoscope accessory in or out to suit your requirements.

Figure 12.



WHIRLING RODS

3-D rods swirl across the screen.

This effect utilizes a colored window wheel in the projector gate as described in wheel assembly (page 13) and a lenticular wheel turned by a 12rpm motor in front of the projector. This can be done as illustrated in Figure 14.

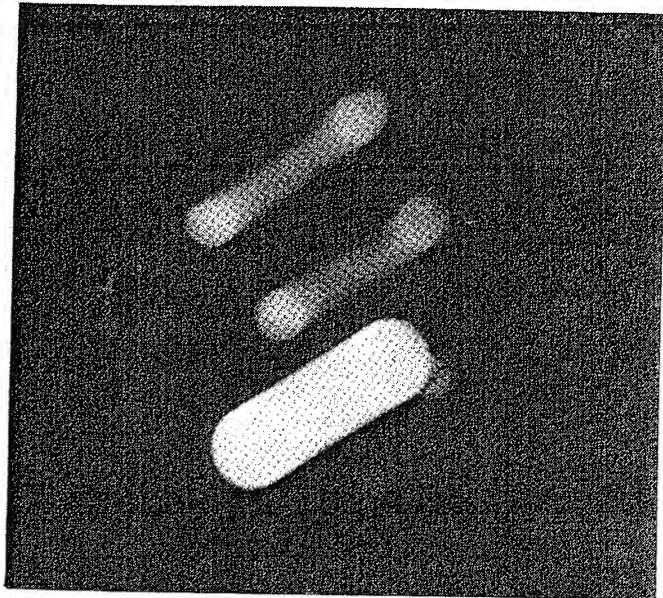


Figure 13.

General Projection Setup When Using Lenticular Wheel

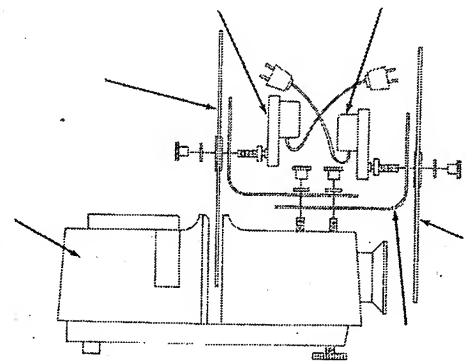
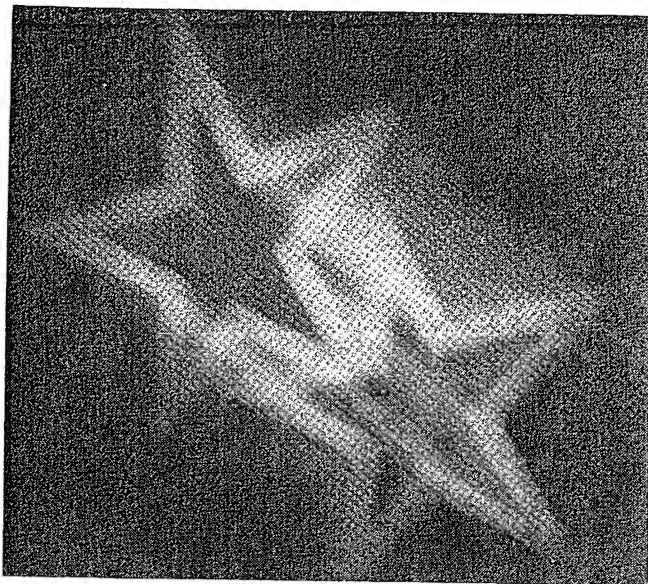
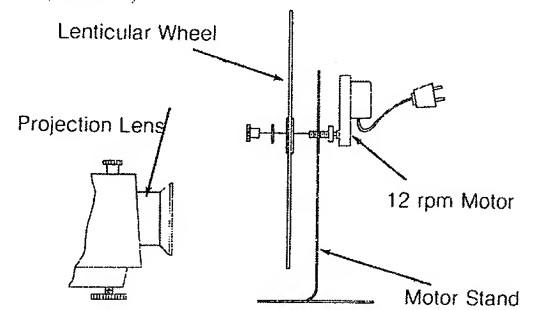


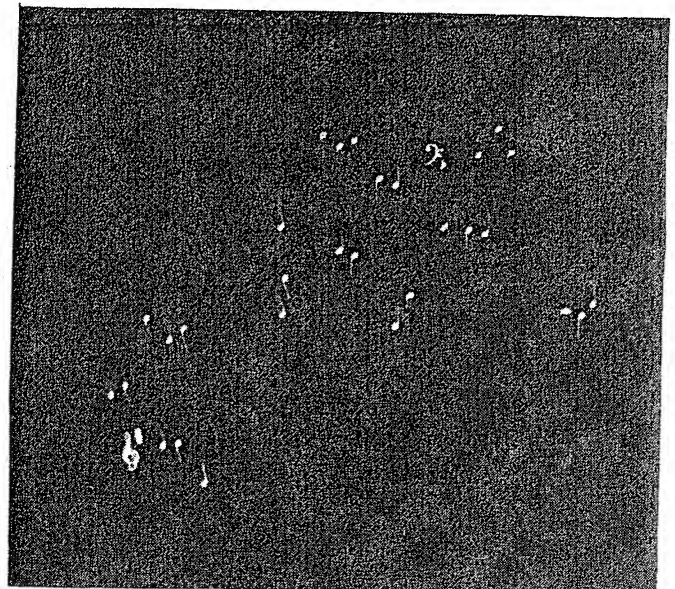
Figure 14.

Lenticular Wheel Mounted On A Separate Motor Stand



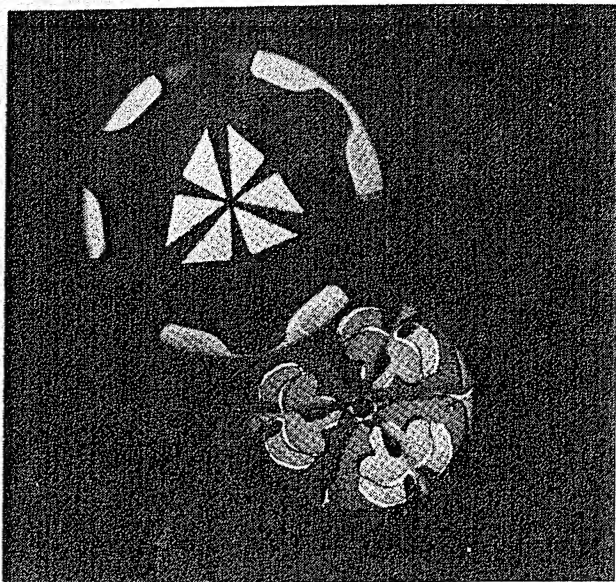
3 DIMENSIONAL EFFECT

Same as whirling rods but using the 3-Dimensional geometric wheel instead of colored window wheel.



MUSIC NOTES

To create the effect of musical notes, place the Music Note Wheel in the projector gate as described in wheel assembly (page 13). The drifting and flowing notes will move gaily across the screen. If you want the notes colliding in a unique pattern, try adding the hexidoscope accessory to the lens of your projector.



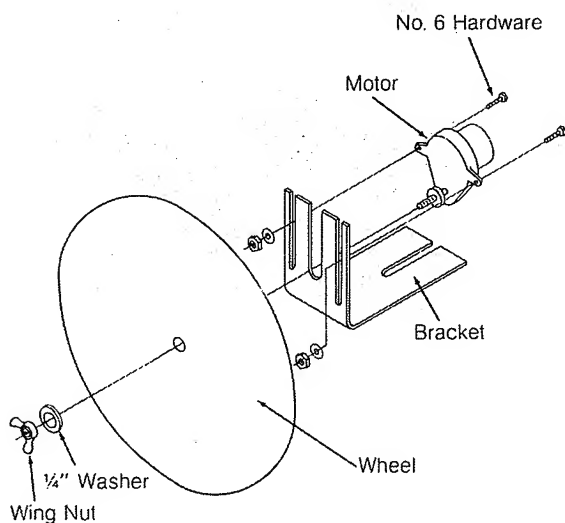
DRY KALEIDOSCOPE

Insert the Kaleidoscope Lens into the Visual Effects Projector. Hold the lens barrel in one hand and focus or rotate with the other (Figure 16).

Directions

Insert wheel desired into motor unit as illustrated (Fig. 15). Attach bracket-motor assembly to projector top with two $\frac{1}{4}$ -20 nuts and washers. Be sure wheel fits into gate area properly.

Figure 15.



NOTE: A WET KALEIDOSCOPE WHEEL gives an oozing, eerie effect.

Figure 16.

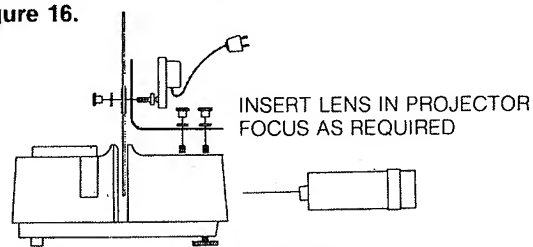
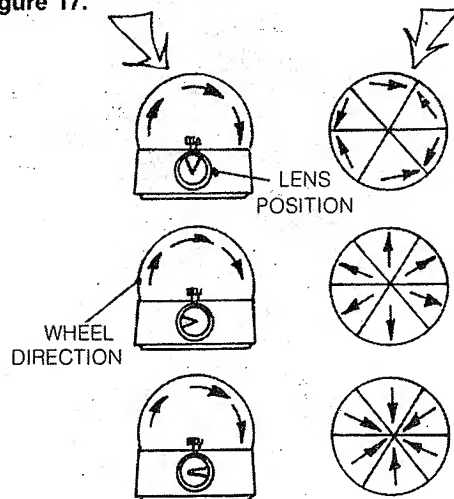


Figure 17 shows how you can achieve 3 different effects by merely rotating the Kaleidoscope Lens barrel. If the mirror "V" is not in the correct position, the screen image will not be round. Arrows indicate direction of design flow. See Chapter 7 for more details on Kaleidoscopes.

Figure 17.



POLARIZERS

Polarization can exist because light is made up of transverse waves. The term "polarization" was applied to light by Etienne Malus (1775-1812) and it is an unfortunate term. He was applying the idea of Newton's "poles" of magnets to light and, while it's not strictly accurate, the name has stuck. Simply stated, polarization of light is a matter of straining light waves. If you think of light waves as travelling both in an up and down motion and in a left/right motion, a polarizer acts as a net to allow only one or the other waves through, or sometimes, no light at all if it "nets" both kinds.

Light doesn't just travel in those two directions, of course, and what a polarizing wheel will do on birefringent material (any substance that breaks the path of light into different directions) is give the light an appearance of movement or animation.

You can make discs of birefringent material (see SLIDES) or you can buy polarized slides and mount them on a wheel. By spinning a polarizing disc in front of the lens at 30 or 60 rpms, you can achieve many beautiful and delicate effects. Dissolved aspirin, allowed to dry on a clear disc, will crystalize into a birefringent disc for a feathery effect.

MOIRÉ EFFECTS

The moiré effect can be achieved in several ways. You can arrange the wheels the way they were for "Whirling Rods", replacing the colored wheel with the Moiré Wheel for a 3-D Moiré effect. For a more psychedelic effect, you can replace the lenticular wheel with a second Moiré Wheel and use a hexidoscope or kaleidoscope accessory lens. This effect also lends itself to use with the 2-wheel effects projector.

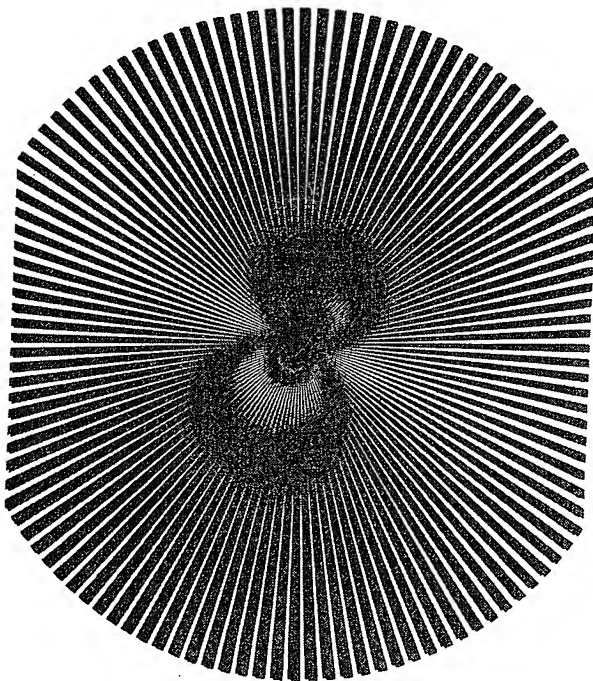
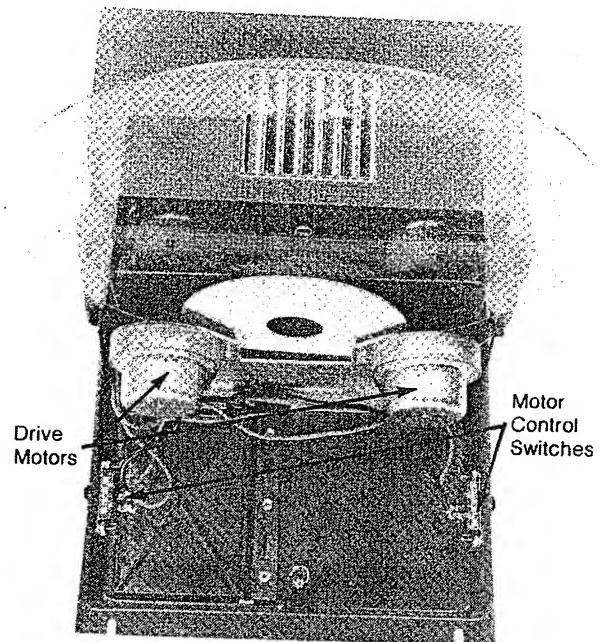
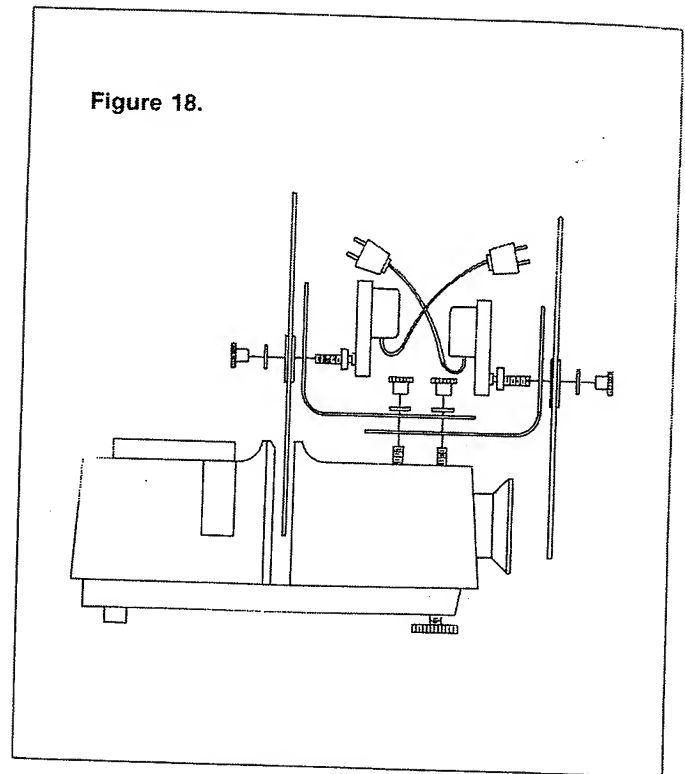


Figure 18.



SPOTLIGHT

The Edmund Visual Effects Projector can also serve as a versatile, sharp-image, show spotlight. By using the 3 included apertures and adding an Adjustable Iris Diaphragm you will have a 500-watt light source to fit all your spotlighting needs.

Maximum and Minimum Image Diameter At Various Projection Distances

Aperture Dia.	PROJECTION DISTANCE			
	10"	20"	30"	40"
Minimum (1/8")	3.5"	6"	9"	12"
Maximum (1-5/8")	50"	108"	135"	195"

LONGER THROW

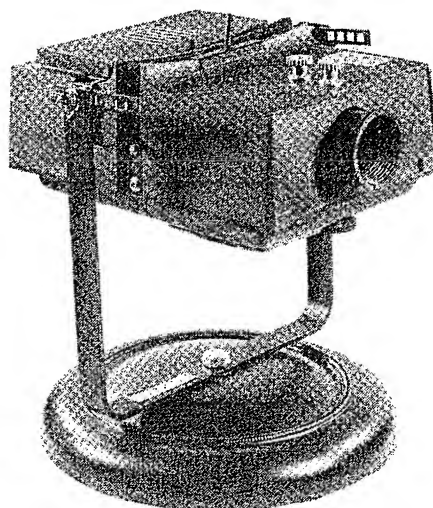
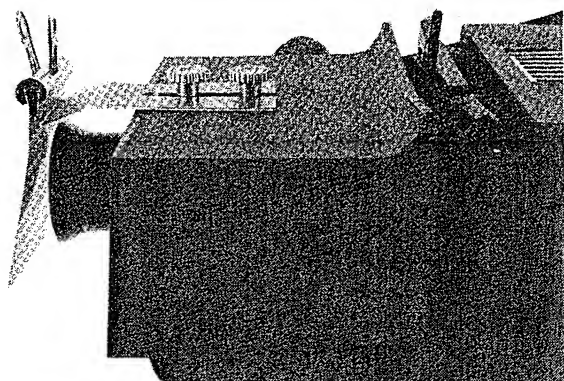
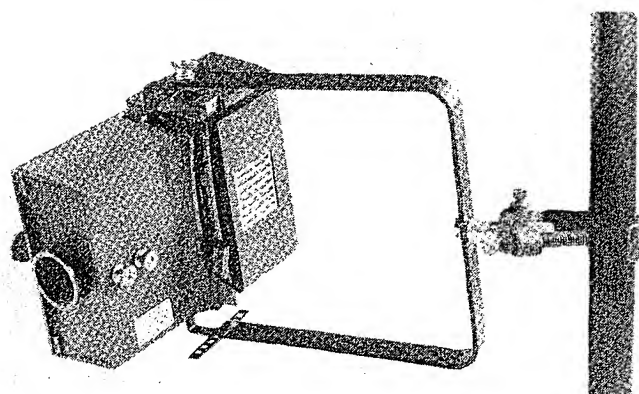
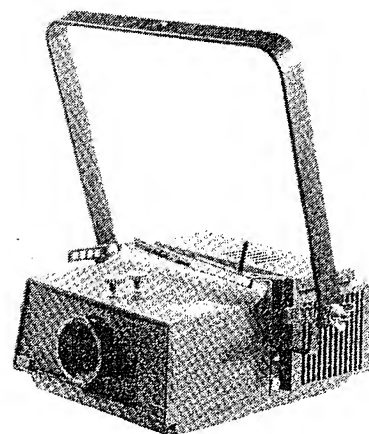
Greater brilliance can be achieved with "long throw lenses." These utilize more of the light available, focusing it more efficiently at the greater distance, instead of merely masking off part of the total light area, as with a shorter F.L. (focal length) lens.

While the spot size with the supplied standard 3" F.L. lens can be varied from a spot diameter of 4 inches to 8 feet at a throw length of 15 ft., a 5" F.L. long throw lens will give this range at 42 feet, and a 8" F.L. lens at 66 ft.

For broad floodlighting, you may find it advantageous to remove the projection lens completely.

COLOR SPOTS

To color your spot, all you have to do is place a simple color filter sheet in front of the lens. A piece of aluminum, bent roughly will allow you to attach a square of color filter with a common spring-type clip.

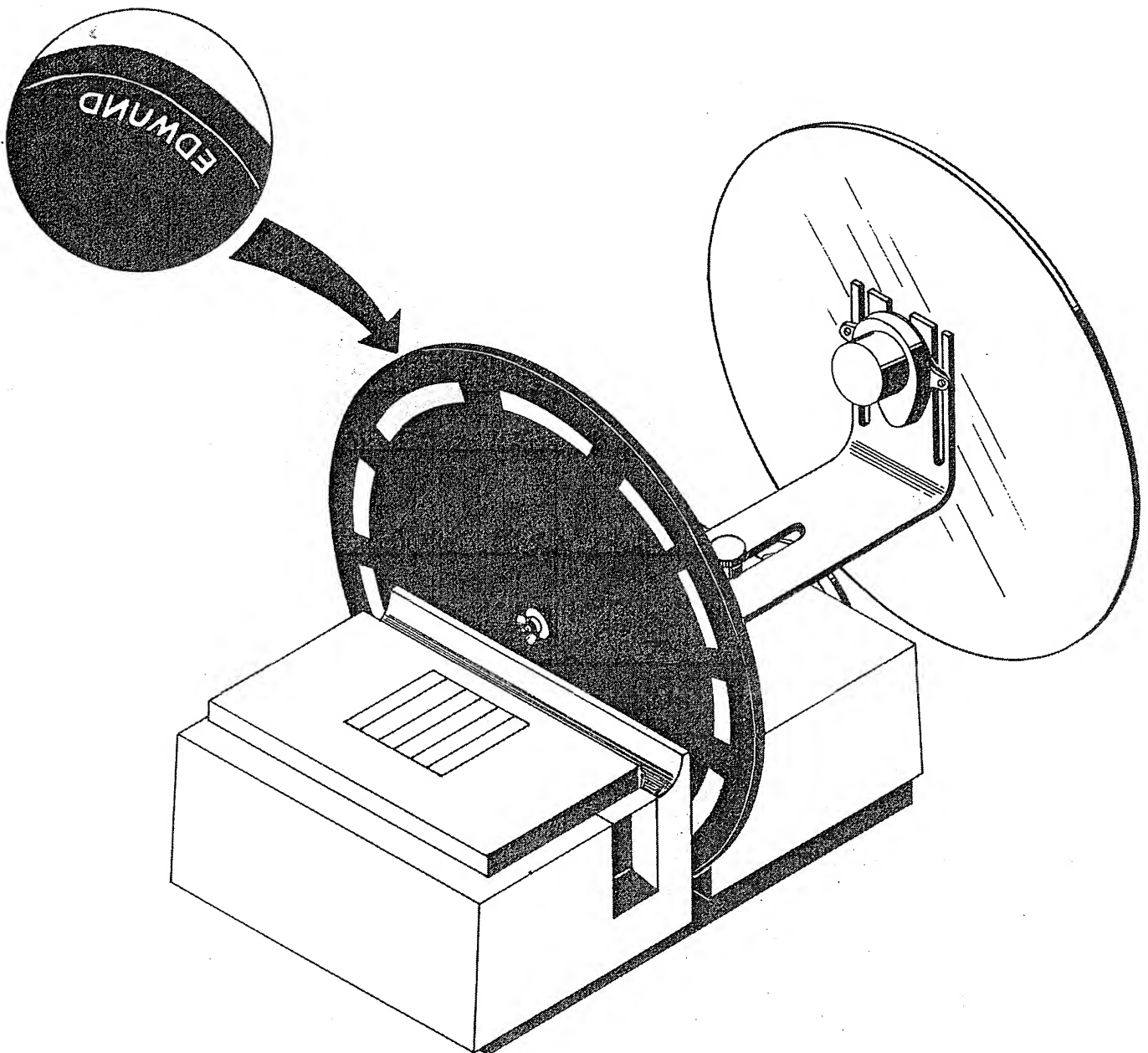


LOGO or NAME WHEEL

This is a dramatic "custom" effect which you can use in a number of situations. Basically, it is a wheel with a stencil of either a word or a corporate logo which turns in the gate at 1 rpm. The hexidoscope lens should be fitted into your 3" lens and a psychedelic wheel should turn at 4 rpm in front of the lensing. Cast on the screen will be a "wheel" of name/logo which seems to grow in spokes out

of the center of the screen. The effect may be varied by not using the psychedelic wheel, by moving the hexidoscope or by using a kaleidoscope instead.

You can make the stencil wheel either by cutting letters out, by reproducing the name on Kodalith[®], or by using some of the other photographic effects kits on the market.



COLOR WHEELS

A disc covered with color filter material rotates in front of a light beam. As one of its colored sections enters the light beam, the beam takes on that section's color. The disc is a color wheel. As it turns, the light beam changes colors.

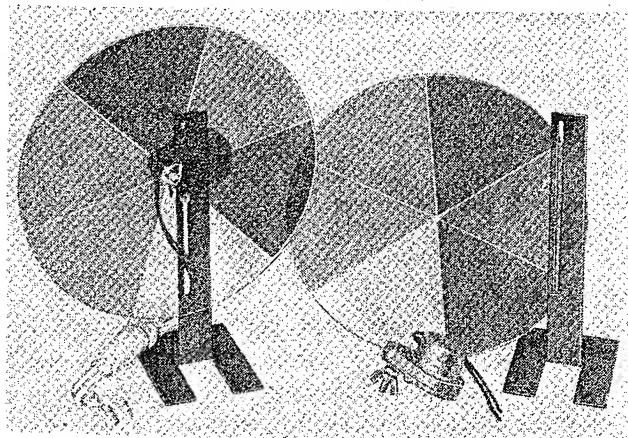
The color wheel offers a useful combination of advantages. Conventional slides, of course, also color light beams, but a moving color wheel continuously changes colors. Light polarization can provide changing color, but a color wheel gives greater and more uniform color control. Since a color wheel is relatively inexpensive, it is an ideal light show tool. It can be used with films, slides, flashes of plain white light, etc.

The color wheels used with Christmas trees and certain displays are usually not acceptable for light show use. These color wheels often have color discs that are made of molded plastic, have ridges and designs, or have color filters that don't transmit enough light. This section deals with color wheels and color wheel materials that transmit plenty of light.

COLOR WHEEL PATTERNS

A complete color wheel usually consists of 3 basic elements: the wheel itself, a stand or bracket, and a motor or some other gadget to provide movement. The most important element is the wheel and its arrangement of color. Color wheels are typed according to the pattern in which color is applied.

The most common color wheel, and usually the only kind you can find commercially available, is the standard type with a 6-segment, pie-wedge pattern of color.



This wheel is popular because it offers different hues; each one colors the light beam for the same length of time if the wheel turns at a constant speed. Each color segment is the same size. This standard type of color wheel is easy to make and is versatile enough for a variety of uses.

MAKING YOUR OWN COLOR WHEEL

You can make your own color wheel in any pattern you choose . . . plaid, checkered, bullseye, crazy quilt . . . paint it, silkscreen it, or use color filters. Choose the application and then make a wheel with the pattern that best fits that application.

A set of 2 acrylic discs can serve as the basis for a color wheel. Glass discs should be used for high temperature applications. Place various segments of plastic color filters on one of the discs. The pattern and the position of each different color is up to you. It's wise to consider the amount and position of each color because this, and the turning speed of the wheel, will determine how long each color and pattern will be in the light beam. Another important fact to determine is the area of the wheel which will be hit by the light beam. This area will color the beam.

After you're satisfied with the pattern, place the other disc on top of the segments of color filter material. This "sandwich" is then sealed with tape or glue. Make sure these discs are tight. Discs with too much space between them will allow the plastic color filters to shift when the wheel is turned. This would ruin your pattern. Tape can be used to hold the filters. Position the tape outside the light beam area.

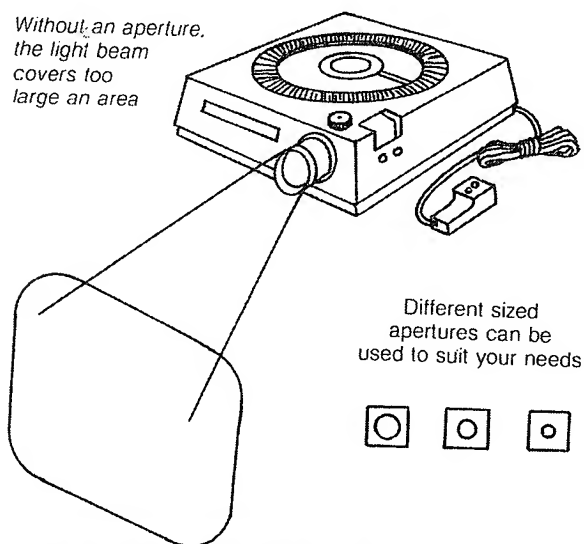
Another way to make a color wheel is to use only 1 acrylic disc. To this disc, add self-adhesive color filter sheets. These can be cut and positioned on the wheel in an arrangement appropriate to your needs. You can also use spray adhesives.

Color wheels can be made without using color filters. This type has a color pattern painted in transparent projection paint. Only 1 disc is necessary. If you're not skillful with a paint brush, try some of the slide painting ideas in Chapter 14.

When completed, the color wheel disc is mounted on a stand (usually with a motor) and is ready for placement in front of your light source. The stand can be purchased or

made using materials often found around the house. You can make a crude stand by bending hangers. Bookends can also serve as a stand. If the color wheel is to be used in light shows or in any other application where it will often get a lot of hard use, buy a sturdy stand. The small expense is better than continually repairing or adjusting homemade versions.

The color wheel disc is spun manually or by a motor. Motor-controlled color wheels are best for light shows and many other applications. A series of inexpensive motors marketed by Edmund Scientific Co. offers you a variety of speeds to select from. Variable-speed motors, possibly with some type of remote control, will give you extra versatility by having different speeds for different effects. Such motors are normally expensive, but can sometimes be salvaged from old mixers or blenders. Instructions for building a manual motor are in Chapter 10 on strobos.



COLOR WHEEL APPLICATIONS

Color wheels can be used with almost every other unique lighting tool mentioned in this book. They're that versatile. They can be used to color spotlights. They can color the flecks of light reflected from a mirrored ball or flexible mirror (Chapter 6). Color wheels can color lumia's antishapes (Chapter 8). These applications are explained in their respective chapters. Here are a few that aren't:

Coloring Beams with a Projector

Projectors with color wheels get a lot of use in any light show. The Edmund Visual Effects Projector is an ideal unit for light shows because it has special bolts for attachment of brackets that hold color wheels and other special effect wheels. This couples the projector and color wheel into one unit that can be positioned easily. If you don't have this projector, you will need to attach a color wheel to your projector or position one in front of its lens.

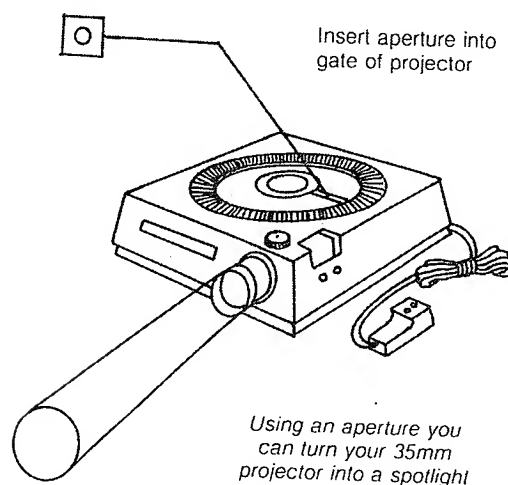
If you choose to keep the color wheel separate from the projector, a little experimentation with different lens-to-wheel distances is recommended. Place a standard color wheel so that the projector beam covers one color section, but no more. Watch the spot that's projected on-

to the wall or screen. Incidentally, be sure to place the wheel off to one side of the beam. This is done to prevent the beam from striking the center of the wheel which would cause part of the beam to be blocked by the stand. Now, note that the light beam and the spot produced are one color. As the wheel is turned, the spot has two colors and then just the second color.

Move the color wheel farther from the projector until the beam covers two wheel segments and no more. When the wheel revolves, the spot has two colors, then three, and back to two colors again. By moving the color wheel closer to or farther away from the projection lens you can control the number of colors in the beam at any one time.

Color Wheel Spotlight

Try this idea for a low-budget, variable-color spotlight. By placing an aperture in the slide gate of a 35mm



projector or the Edmund Visual Effects Projector you can convert it to a spotlight. A color wheel in front of the projection lens adds the color. Play the colored beam on the performers and you'll have a professional looking effect without extra expense.

Because a spotlight is moved to follow the action on the stage, it is better to have the color wheel attached to the projector. The operator will then only be required to move one piece of equipment.

Black & White Color Slides

Color wheels spun in front of a projector showing black and white slides can give excellent effects in a light show or home slide presentation. By coloring the white areas of the slides, the color wheel provides interesting and seemingly changing slides. Use a fast motor on your color wheel and it will change colors so quickly that the slides will appear to blink.

Color Mixing

A color wheel is an excellent partner for organic or color filter slides (Chapter 14). The colors on the wheel and those on the slide will blend in the beam. The blue sections of your organics will turn green when a yellow color-wheel segment passes in front of the beam. A red portion

of a color filter slide will turn orange under the same yellow segment.

The faster the color wheel turns, the faster the colors will change on the screen. Use a fast motor for a blinking effect and a slow motor for more subtle color changes.

Color Wheels & Special Effects Discs

The previous chapter mentioned discs that are made especially for Edmund Visual Effect Projectors. Special effect discs will fill your screen with moving colored patterns. Try rotating a color wheel in front of the projector gate. The effect is fascinating. Turn the disc at one speed and the color wheel at another. The colors will blend and flicker.

If either the disc or the color wheel has a textured finish, the screen image will never be quite in focus. This is often a desirable effect, something like underwater photography. A rippling, underwater effect can also be achieved by spinning a distorted, clear plastic wheel in front of the projector. Such a wheel can be made by heating an acrylic disc in an oven until it softens. Then bend and ripple it. The completed disc will look something like a phonograph record that was left on a hot radiator.

The Colored Strobe Attack

You can use a color wheel to color the flashes of strobe lights. Since a strobe is a highly divergent light source, you will need a large color wheel spinning right in front of the strobe, the closer the better.

Aim the color-wheel strobe at bubbles, performers, mirrored balls, or on posters. Colored strobes are particularly effective when used on posters printed with colored inks. Careful selection of color filters used on the color wheel is recommended because these will cause different poster colors to blink at different times.

It is easier to use a color wheel with a mechanical strobe than with the electronic or fluorescent types. This is true because it's hard to synchronize a strobe's flashes with a particular segment of a color wheel. Unless the synchronization is perfect, you're likely to get a flash when portions of two different segments of the color

wheel are in front of the strobe. This gives undesirable, 2-colored flashes of light.

A mechanical strobe's flashes can be colored without this problem. Use the perforated disc mentioned in Section 3. Cover its holes with color filter material. As each hole passes in front of the light source, a flash of light, the same color as the filter, will blast your strobe's attack target.

Synchronizing an electronic or fluorescent strobe with a color wheel is not impossible. These strobes must be modified to utilize a microswitch and cam on the color wheel which will trigger the strobe's flash. The microswitch and cam should be set up so that they trigger the strobe each time a different color is in front of it.

Color Wheels of a Color Organ

For this application you need a color organ, several projectors or spotlights, and several color wheels; one projector or at least one spotlight for each channel of the color organ, and a color wheel for each projector or spotlight used. In this discussion we'll say you're using projectors.

It's best to use just a few shades of one dominant color on each color wheel. If you'd rather use pie-wedge color wheels, make them with a group of similar colors on each wheel; blue and green for one, yellow and orange for another, red and pink for a third, and so on.

Connect the projectors to the color organ, one to each channel. Aim them all at approximately the same spot. Start the colored wheels spinning in front of the projectors and turn on the music. The colors will flash and pulsate on the screen in response to the music. This setup gives the perfect blend of controlled and random color.

If you don't have enough projectors or spotlights, use a combination of both. For more information on color organs, see Chapter 5.

NOTE: When using projectors, only the lamps should be connected to a color organ. The fans must run at all times. With most projectors, the switch is left on the "fan" position and the remote control takes the lamp up and down.

COLOR ORGANS

HISTORY OF COLOR ORGANS

Probably for as long as color and music have both existed there have been schemes for combining them, for mixing the arts or "mixing the media." The schemes manifested themselves in sentimental references such as Whistler's tendency to call his paintings "nocturnes" and "symphonies."

In the latter half of the 19th century, books began to appear advancing the theory that music and color have an analogous relationship and should be combined. After all, music was combined with the theater, why not with color and painting? The first book of this type, J.D. McDonald's "Sound and Color," was published in 1869. In 1883, F.J. Hughes wrote a book entitled "Harmonics of Tones," suggesting a system for keying colors to notes. In 1884, D.D. Jameson wrote "Color Music," which proposed additional theories on sound-color combinations. These 19th century theories would have been useless if a machine hadn't already been invented that could "play" colors meaningfully, and rhythmically... the way music is played.

The earliest reference to such a machine, recorded in 1725, credits a French Jesuit priest, Father Lewis Bertrand Castel, with its invention. He developed a "clavecin des couleurs" (organ of colors) to make sound visible and interpret it in color. The colors were arranged in a diatonic keyboard and were played simultaneously with their corresponding notes in music. Father Castel also had a scheme for musical and harmonic tapestries in which paintings were to reproduce all of the effects of opera and cantata. Incidentally, he also developed a "clavecin des odeurs" (organ of odors) with the same type of diatonically arranged keyboard. This instrument was designed to give concerts in perfumes.

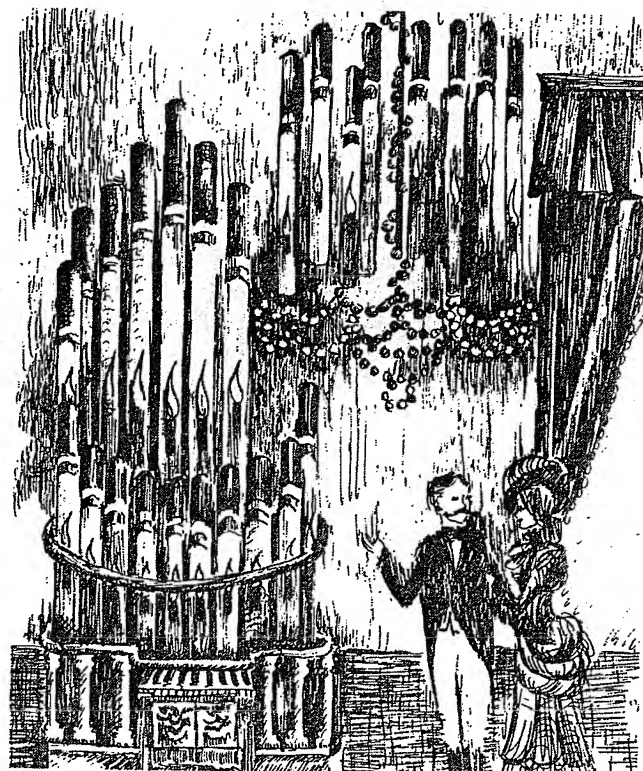
Castel and his double-sensed organs were forgotten for years. Then, in the mid-19th century, the concept was revived. A color organ, built in Paris, was taken on tours to many of the national fairs of Europe. Like the Castel organ, this instrument provided a musical and a color response to the same key. The keyboard controlled a series of gas jets, each in a tinted pipe. When a key was depressed, a flame would rise in the appropriate pipe. As it burned higher, it started the air vibrating in the pipe and thus produced tones. Each pipe glowed in varying intensity with the varying intensity of the music.

Up until the middle 1880's, colors were arbitrarily matched with musical notes, generally according to the whim of the organ manufacturer. Then, close to the turn

of the century, professor Alexander Wallace Rimington of Queen's College, London began to work on a note-to-color matching theory. Building on the earlier work of Hughes, Jameson and McDonald, Rimington developed a mathematical scheme for assigning color to sounds. Then, he built a projection color organ to show his theory to the world. Here is his version of that theory.

"Taking the spectrum band as the basis of all colours, there are two remarkable points of resemblance between it and the musical octave... The first of them is that the different colours of the one, and the different notes of the other, are both due to the various rates of vibration, acting on the eye or the ear..."

...If we measure the rate of vibration at the first visible point at the red end of the spectrum, we shall find it is approximately one half what it is at the extreme violet end. Now in music, as we all know, this relationship is the same. If we take the first and the last notes of the octave... the latter has nearly double the number of air vibrations and the first note of the new octave has exactly double. This is the case also with the spectrum band. So far as one octave is concerned, the lowest red stands for the first note of the octave and the highest violet for the 12th or last note..."



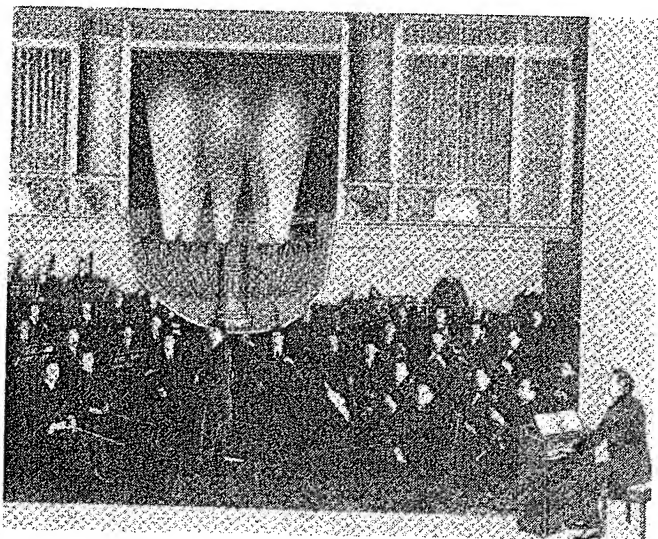
Rimington's Conception of the color scale

DIVISION OF COLOR SCALE UPON KEYBOARD COLOR-ORGAN WITH MIDDLE C CORRESPONDING TO LOWEST RED OF SPECTRUM

Approximate ether vibrations Mil. mil. per sec.	395-0	433-0	466-0	500-0	533-0	566-0	600-0	633-	666-0	700-0	733-0	757-0	Invis- ble
Approximate color	Deep red	Crim- son	Oran. Crim- son	Or- ange	Yel- low	Yel- low- green	Green	Bluish green	Blue- green	Indigo	Deep blue	Violet	
Musical Note	(Mid- dle) C	C#	D	D#	E	F	F#	G	G#		A#	B	C ₁
Vibrations per sec.	256-0	277-0	298-0	319-0	341-0	362-0	383-0	405-0	426-0	447-0	469-0	490-0	512-0

Using these basic analogies between music and color, Rimington divided the spectrum into diatonic intervals, or notes, on the same plan as the musical scale. The keyboard he developed, "played colors." It made it possible to write color compositions using essentially the same system of notation as a musician. Using that notation system, he could translate musical scores into color.

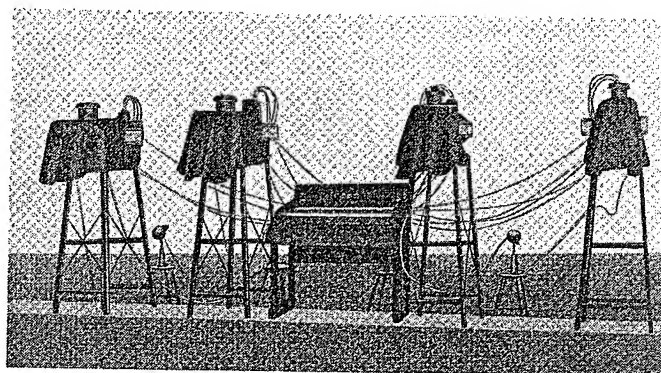
Color organ popularity snowballed. Color began to accompany serious music concerts. In July of 1915, a color organ appeared in New York's Carnegie Hall. There, the Russian symphony orchestra produced Alexander Scriabin's "Prometheus: Poem of Fire." The color instrument was constructed especially for the concert by the Electrical Testing Laboratories in New York with lamps made just for this instrument by the General Electric Company.



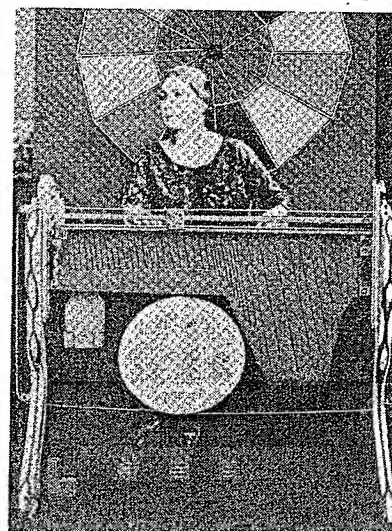
The concert used a note-to-color scheme which ran as follows:

C	Red
D	Yellow
E	Pearly Blue
F-Sharp	Blue
G	Turquoise
A	Green
B-Flat	Steely Gray

The Kiel Music Festival of 1925 included a performance by the Hungarian pianist Alexander Laszlo on a color-light piano.



At about the same time, another color musician, Mary Hallock Greenwalt, decided to challenge the classic Rimington theory that certain colors can be attached to specific musical notes. She maintained that no sound finds an exact counterpart in any one color. She also noted that few musical compositions excite the same sensations in every director or performer. Her feeling was that colors should not be tied inflexibly to notes. Instead, each color organist must be left free to interpret for himself the composition he is accompanying. Mrs. Greene-



walt's color organ compositions were never meant to be silent. They offered visual accompaniment to sound of music.

By the mid 1920's there were dozens of color organists making concert tours. One such "musician" was Thomas Wilfred who gave color concerts with his "Clavilux." He used this keyboard-operated color organ to project giant flashes of light onto a roof-mounted outdoor screen. He called this his "Temple of Light." Reviews of his work in major European and American papers acclaimed his success. The London Times noted, "We have here a new art, based on legitimate attraction and capable of logical exposition and extension, which is bound to make its way with those susceptible to artistic influences." The Copenhagen Politiken called Wilfred's work "the first manifestations of a new and glorious art form that will lead our imaginations along hitherto untrod-den and wonderful paths." The San Francisco Examiner stated, "The Clavilux will enable us to do with light what Dante did with words in his description of Paradise." And the New York Times said the performance seemed to "Call on senses not yet fully active." Wilfred demonstrated his "Clavilux" around the world from a small auditorium in Bloomington, Illinois to the Danish Royal Opera House. He had become, as one reviewer noted, "the prophet of a new art."



COLOR ORGANS TODAY

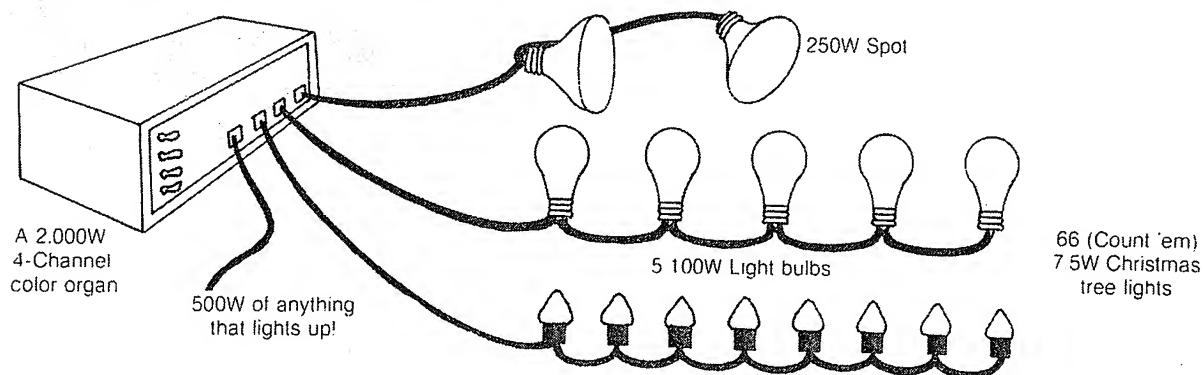
Today's color organ is an electronic version of the 1920's classic model. Musical tones trigger circuits which automatically light colored lamps. Each circuit responds to a different tone group. Bass notes trigger one channel; high notes trigger another. And a full range of middle notes will trigger other circuits or channels and light other groups of lights.

Conspicuously absent from the process is the "musician" who once played the colors. He is no longer needed. Music or sound is introduced into the modern color organ through a microphone or a sound source (radio, tape recorder, phonograph). Once the sound enters the color organ, the highs, middles and lows are sorted and used to modulate a colored light source.

Automation of the color organ has considerably widened the area of its uses. Today, the color organ not only colors music and performances, but also translates the human voice and any other sound into light and color. It can be used with serious music or at rock concerts, at the theater, or in the home. Color organs are commercially available in 1, 2, 3, and 4 channel models. Some specially produced color organs have over eight channels, one for each octave of the sound spectrum. The one-channel color organ connects to a group of lamps which dim and flash according to the intensity of the sound. But since this color organ has only one light-control channel, the lamps will always dim and brighten together.

In multiple-channel color organs, both the intensity and the pitch of sound modulate the lamps causing them to flash, sometimes alternately, sometimes together. Most present color organs can handle between 50 to 500 watts per channel and it's a good idea to match the wattage capacity of each channel to the wattage of the lamps controlled by the channel. Each channel of a 2,000 watt, four-channel color organ, for instance, can modulate two 250-watt spotlights, five 100-watt incandescent light bulbs, or up to sixty-six 7.5 watt Christmas tree lights.

Some color organs are currently marketed with built-in microphones. Other models are connected directly to an audio source and use input jacks or wires that connect to speaker terminals. One variety uses a combination of both microphone and direct connection with a control that allows mixing of the two inputs.



Color Organ Usage Is Growing Rapidly

In these times of light shows, discotheques and psychedelia, the interest in color organs has increased greatly. More and more people are learning about color organs as they see them in use. For example, millions of Americans and citizens of other countries first became acquainted with them when they saw them in use at the Seattle and New York World Fairs.

Color Organ in the Discotheque Light Show

In the discotheque, the color organ is a light show in itself. It can be used to sound-synchronize a whole lighting environment, or it can be used to trigger a few colored spots or floods aimed at a performer. A color organ can be used to control all of your room lights. Just connect each channel to a separate lighting circuit controlling, perhaps, a dozen ceiling-mounted, incandescent, light bulbs. The varying musical tones, picked up by the color organ, will brighten and dim each series of bulbs to the beat and melody of the music.

For a similar effect, connect each channel of a four-channel color organ to a separate lighting circuit. Instead of using incandescent light bulbs, this time use colored spots or floodlights, also ceiling mounted. Beneath the colored spots, build a subceiling of translucent panels. The electric ceiling might be activated by a highly sensitive microphone. This makes the electric ceiling sensitive to every noise in the room. Walk into the room. Close the door. And the ceiling will light up. With such an arrangement, a discotheque filled with dancing patrons and a rock band, will come alive with lights that flash and flicker to the beat of the music. Or, you can use a juke box or a record player to modulate the color organ lamps.

Sound Sources

One highly-versatile audio source for a color organ is a live microphone that's plugged into the organ's "input jack." This can pick up human voices and live bands, or it can indirectly pick up sounds from a juke box or hi-fi speakers. Sound from a radio, tape recorder, phonograph, or juke box can also be fed directly into the color organ by connector cable and appropriate connector plugs. One plug goes into the audio-source output jack, the other goes into the color-organ input jack.

What to Project On

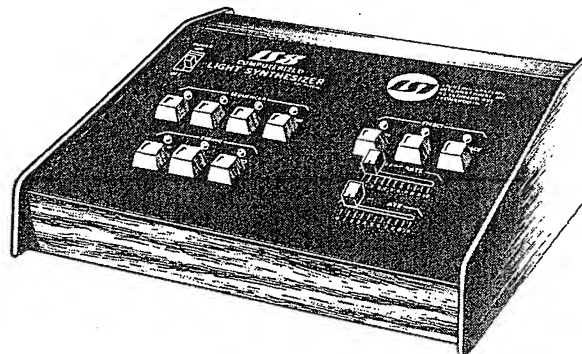
Projecting color-organ spots on a live, moving subject adds form and motion to the music and color. You will find many such subjects in a discotheque. Performing dancers will look much more interesting bathed in constantly-changing, colored lights. The color-organ lamps can be projected on performing rock bands.

You can color-organ spotlight a discotheque's dance floor or your recreation room by mounting spotlights on the wall or by hanging them from the ceiling. Connect the spotlights to a color organ and you're in business. The patrons of a discotheque will enjoy dancing under lights that flash colors to a tune's tones as they "do their thing" on the dance floor. Any party in your recreation room will be lively and exciting in a color-organ controlled atmosphere.

Fascinating results have also been achieved by projecting color-organ spotlights on Edmund mirrored balls which are ceiling-mounted all over the room. Light from the spotlights is chopped up and tossed about. The tiny flecks of light dim and change colors with the changing tones and volume of the music.

Recap

The variety of color organs available today is almost limitless. If your budget is small, you might consider investing in one or two low-cost color organ lamps. If you have a more sizable budget, you might want to consider a more sophisticated device such as the LS-8. The LS-8 uses microprocessors and solid-state design to control 1000 watts on each of 8 channels. From the control console, you can "direct" any one of eight patterns of light including a "random" effect. Two further controls allow you to dictate the rate at which the patterns occur and the fade time between one step and another. When you've chosen a given pattern, you can either let it "run" automatically or you can "step" through it in time with music. The effect of pulsing rhythm may be achieved by timing the step and decay rates of your effect to match the syncopation of a given musical piece or you can patch it into your sound system.



MIRRORED MATERIALS

After light sources, mirrors are probably the next most important tool in a light show. Using mirrors, you can ricochet light from one surface to another. Mirrors can help you to distort light, break it up, and bounce it about the room for eerie or "cheerie" lighting effects.

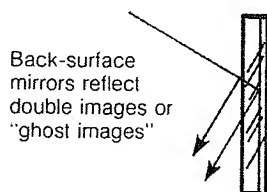
Front and Back Surface Mirrors

Front-surface (first-surface) mirrors reflect an image more sharply and brightly than do back-surface (second-surface) mirrors. Back-surface mirrors give hazy, double-image reflections.

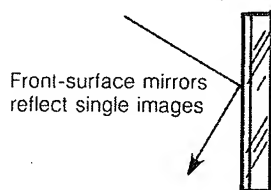
How can you tell what kind of mirror you have? It's easy. Touch the tip of a pencil or another sharp object to the mirror's surface. If the object appears to touch its reflection, the mirror is front-surface. If the object doesn't seem to touch its reflection, the mirror is the back-surface type.

Back-surface mirrors are less expensive than front-surface mirrors, and are often used where exact reflected images are not necessary. They give what optical engineers call "ghost images." Sometimes, however, ghost images are desirable.

When a beam of light hits a back-surface mirror, two parallel beams are reflected. The light beam is really reflected twice. The first reflection is from the outermost (first) surface of the mirror. The second is from the back (second) surface of the mirror. This double reflection is the cause of ghost images.



Back-surface mirrors reflect double images or "ghost images"



Front-surface mirrors reflect single images

Mirror Balls

When a light beam hits a spinning, mirrored ball, each mirror struck by the light reflects a different portion of it. The beam appears to be smashed into bits and pieces and tossed about the room. The effect is fascinating. The tiny flecks of light dash and fly around the room as if they were stars in space sailing by a spacecraft's port-hole. Different sources, of course, give different effects.

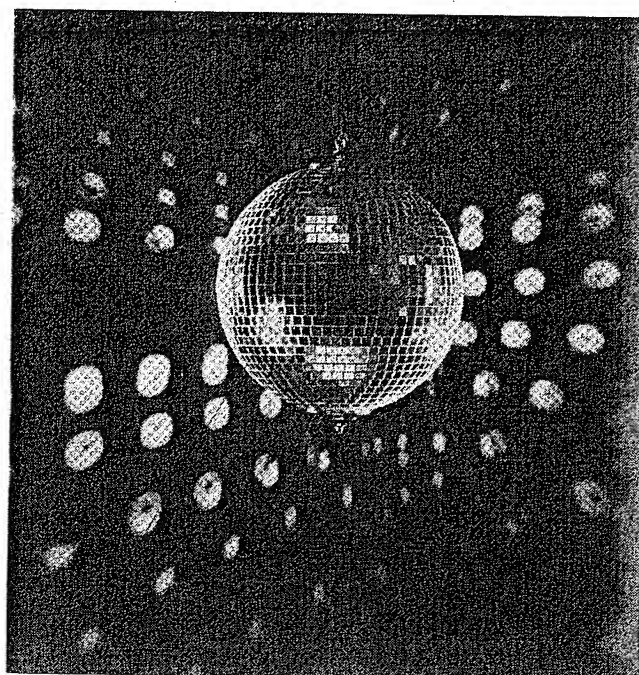
Mirrored balls can be tiny (some are even worn as earrings) or fairly large (2-3ft. dia.). Their application determines the required size.

When you look up and see one spinning on a theater's ceiling, you might think that the ball is heavy and solid. It just looks that way. Actually, mirrored balls are very light in relation to their size. This is true because they usually have centers that are hollow or of lightweight papier-mache type materials.

The mirrors used on these balls are back-surface mirrors with a lustrous finish. Their size varies with the size of the ball . . . the larger the ball, the larger is the size of each individual mirror. However, all the mirrors on any one ball are usually the same size. The number of mirrors used depends upon their size and on the measurements of the ball. Some mirrored spheres have as many as 1,000 mirrors.

On the top of a mirrored ball, there is usually a metal hook or loop. This provides a means of attaching the ball to a ceiling motor, wire, string, etc., for hanging from the ceiling.

There are many ways to use mirrored balls in unique lighting applications. The following examples will give you some idea of how you can use them to create interesting, light breaking effects.



Fracturing Light

Attach a mirrored ball to a ceiling-mounted motor. Set the ball spinning. Use a parallel or nearly parallel light source. A 35mm projector will do. Turn out the room lights and turn on the projector. When the projector's beam strikes the spinning mirrored ball, it is reflected as many fragments of light that shoot by you around the room. The dark room, the speed of the moving light fragments, and the distortion that these fragments undergo as they skip across the corners of the room, all contribute to a dizzying, yet fascinating, sense of motion. . . a unique experience.

Add Color

The sight of bright, white light fragments dashing about the room can be improved by the addition of color. You can do this in many ways. The equipment you own, the room in which it's to happen, and the effect you want to achieve will help determine how you add the color.

Perhaps the easiest way is to color the light beam itself. You can do this by rotating a color wheel in front of the projector or by placing three or four different colored strips of transparent color filters in front of the projection lens. The color wheel gives changing colors, while the latter method gives colors that remain the same on their respective reflection areas of the walls and ceiling. With a color wheel, you can make the light fragments seem to go faster or slower by spinning the wheel in the opposite or same direction as the spinning ball.

Both of the above methods have the disadvantage of just being able to make certain areas of the ball only one color at a time. You can intersperse many colors by coloring the mirrors on the ball rather than by coloring the light beam. To do this, paint the individual mirrors with various colors of transparent projection paint, or by attaching a different square of color filter material to each mirror. . . eight or nine different colors are plenty.

Scattered Slides

Slides can add color plus stark, scattered images to mirrored ball effects. The mirrored ball should not have been painted or have color filters on it. This would interfere with the colors on the slides.

Place a color slide in the projector and project it on the spinning mirrored ball. You will see slide fragments travel past you about the room. Use a landscape slide, and the mirrored ball will put you in the picture. The closer the projector is to the ball, the more you'll recognize the fractured slide images spinning around the walls.

Motion Pictures

Projecting a motion picture on a mirrored ball will give something near the ultimate in reflected image motion. The spinning ball plus the movement of the film will create a fantastic moving scene around you.

Keep in mind that the closer the projector is to the ball, the more recognizable will be the images.

Kaleidoscopic Color

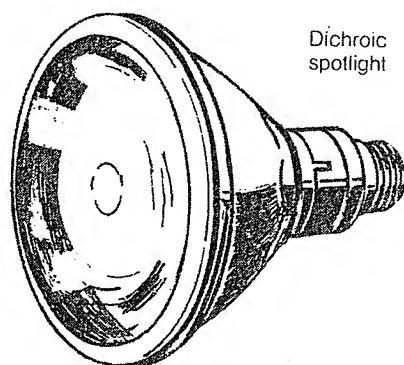
For a color and motion experience that will fascinate you and your audience, use a kaleidoscopic lens and project on a mirrored ball. The room will fill with shattered kaleidoscopic sections, bits and chunks of flowing, undulating color.

Spotlight Sports

Dichroic spotlights are much less expensive than projectors and are acceptable light sources for mirrored balls. These units have internal vacuum coated filters and give pure, rich color. Their relatively narrow beams (30°) are perfect for dramatic display lights. Dichroic spotlights can't provide the sharp, evenly lit, mirror reflection that projectors can, but they do a pretty fair lighting job. They also come in various colors.

Aim them at a spinning mirrored ball from various angles. You will fill the room with colored fragments of shattered, reflected light; one set of colored fragments for each different dichroic used.

Regular low-voltage spotlights can also be used with mirrored balls. Dichroic spotlights are better, however, because of the full, rich color of their beams.



Dichroic
spotlight

Strobe Sports

Stroboscopic light is not collimated light, but enough of it will strike a mirrored ball to give you a desirable effect. Strobes (Chapter 10) make the fragments of light blink on and off. Unfortunately, these light fragments will not be the only light in the room. The strobe will light the whole room, but there will be enough contrast to show the mirrored ball's reflections. . . reflections that will surely add to the stroboscopic vertigo.

Try a Color Organ

A color organ, connected to spotlights or projectors trained on a spinning mirrored ball, will give you fragments of colored light that are music-activated. When the music causes the color organ to actuate the light sources, these light sources blink, flash and pulsate at the mirrored ball. The walls and ceiling become swirling fields of colored light fragments that blink on and disappear to the music.

Flexible-Backed Mirrors And Mirrored Films

Mirrored balls are not the only mirror tools available for light shows and special effects. Mirrors on flexible backing, mirrored films, and mirrors shaped as circles, triangles, or squares can also be used.

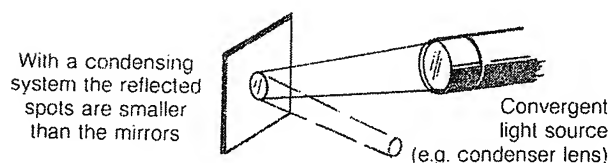
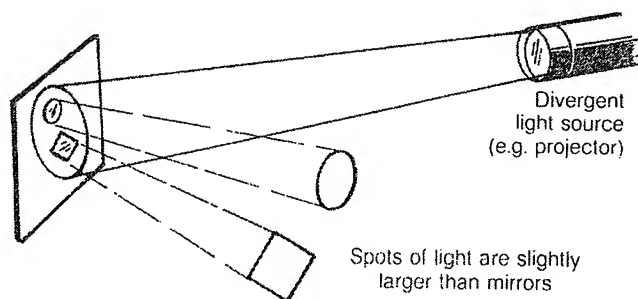
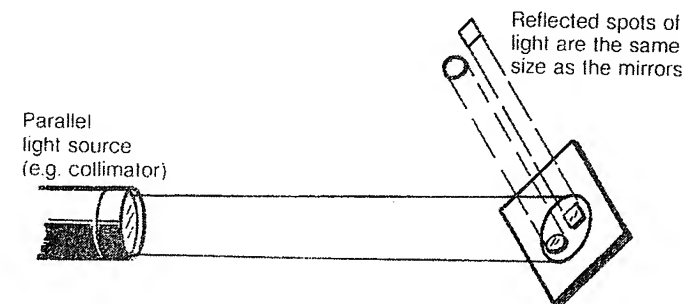
Mirrors on flexible backing can give you effects that are fairly similar to that of a mirrored ball. But these effects will be localized. That is, while a mirrored ball can fill most of a room with reflected images, flexible-backed mirrors can only cover a relatively small area.

Flexible-backed mirrors can be motorized or be operated by an "artist" who directs the flecks of light anywhere in the room by manipulating the mirrors.

Mirrored films, such as aluminized Mylar or plastic, have the same limitation as flexible backed mirrors. These films cannot cover as large an area with reflections as a mirrored ball. Like flexible-backed mirrors, mirrored films can be motorized or operated by someone who would manipulate them in front of a light source.

The reflected images of these films are different from any previously described in this book. The films seem to melt down the light, reflecting it in smoky, wraith-like patterns (lumia; see Chapter 8).

The following are mirrored effects and techniques that you might want to use in your light show, discotheque, or displays.



Light Blasting with Flexible Backed Mirrors

Flexible-backed mirrors let you involve yourself in the light show. Project color slides. Hold the mirrors in the light beam. Watch where the reflected images appear on the walls. Aim them where you choose by moving the mirrors to the proper angle.

It's easy to develop a light tossing technique with flexible-backed mirrors. If you want to keep the fragments of light in one area, don't bend the backing at too great an angle. By bending the mirrors in a semicircle, you can shoot shafts of light to opposite sides of the room. You won't have to manipulate the mirrors very long to develop good technique.

What light sources are best? You can use most of the same light sources on flexible-backed mirrors and mirrored films as you used on mirrored balls. In general, collimated light sources seem to work best, but divergent and convergent light beams can also be used. The type of light source determines the size of the reflected images. Collimated light produces images the same size as the mirrors, divergent light gives larger images, and convergent light gives images smaller than the mirrors.

Multiple spotlight beams can also be used. Aim the beams of light so they cross at the spot where you will hold the mirrors.

Mirrors In Motion

Attach several sheets of flexible-backed mirrors to a coat hanger. Suspend the hanger on a string. Attach the other end of the string to a motor with a cam attached to its shaft. The motor will jiggle the mirrors.

Bombard the moving mirrors with light beams from a projector or color-organ controlled spotlights. This will give you a roomful-of-light effect similar to that of mirrored balls, and a random pattern of eccentric motion that's generally associated with flexible-backed mirrors.

Post Taste

Dance halls, discotheques, taverns, and hotel lobbies always have pillars or posts somewhere. Why let them go to waste? Wrap sheets of flexible-backed mirrors around the posts. Use them to reflect light by surrounding the posts with spotlights, possibly controlled by a color organ.

Mirror Sculpture

For a glittering figure that will attract attention under almost any kind of lighting, begin with modeling clay fashioned in the shape you want it. Bake it in an oven until it's dry and hard. Or, you might use papier mache instead of clay. When it's dry, glue mirror fragments to the surface. Small mirror circles, triangles, and squares are available at low cost.

Using this method, you can build large, mirror coated statues for theater and discotheque props. Play different colored lights on them. If you prefer less sharp or more diffused light reflections, try sculpturing aluminum foil.

Mirrored Hemisphere

Mirrored hemispheres scatter light much the same way mirrored balls do. You can make one by gluing mirrors to the outside of bowls, you can make two by cutting a mirrored ball in half. Place the hemisphere on a rotating stand and play lights on it from all angles. The lights are usually ceiling mounted. The ceiling and walls will fill with moving flecks of light.

Mirrored Clothing

For an exciting reflection effect, attach mirrors to performers' costumes or make a complete costume of mirrors. Mirrored clothing for rock performers and mirrored mini skirts for go-go dancers will create a stir. If you think a complete mirrored outfit is too much, place the mirrors on strategic areas of a regular costume.

Play spotlights or projectors on the mirrored entertainer and watch the reflections on the walls and ceiling.

Mirrored clothing does have two disadvantages. It can be heavy and hot.

Mirror Cutting

Never shatter a mirror to get smaller mirror fragments. This is unsafe and considered unlucky by some. It is just as easy to cut a mirror as it is to break it. Use a carbide or diamond tipped scribe or a wheel type glass cutter.

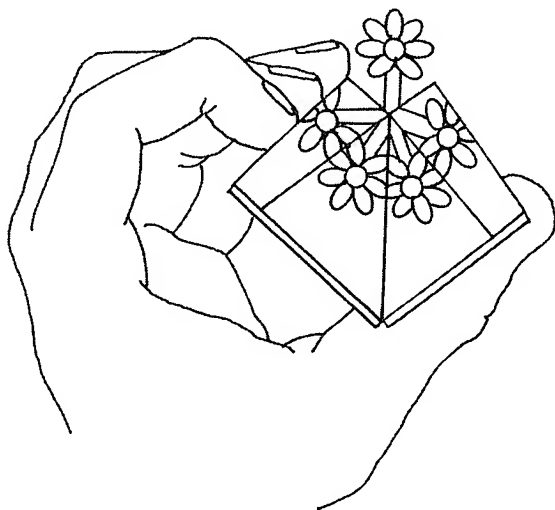
You scratch a line along the areas you want to cut off. Apply firm, uniform pressure on the cutting tool. Using a ruler to guide your cutter is a good idea. After you've made the line on the mirror's surface, place the mirror on a straight edge making sure that the line is on the edge. Then, tap out or break off the portion with a hammer, scissors, or with pressure from your hands.

If you want to cut an irregular shape, use the same method scratching additional perpendicular lines and tap off one section at a time.

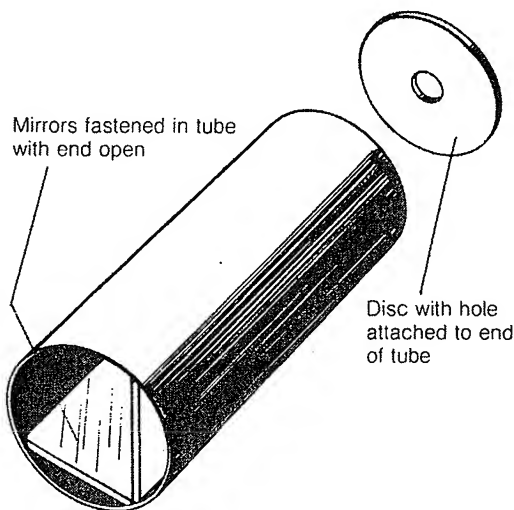
Be sure to cut front-surface mirrors on the front surface and back-surface mirrors on the back surface. This prevents the aluminized coating on the mirrors from peeling off after mirror has been cut.

KALEIDOSCOPES

One day in 1814, a British inventor, David Brewster, positioned two mirrors in a V and held them up to one of his eyes. When he looked through this mirrored V, he saw multiple images of all the objects in his line of sight. When he closed the angle of the V, he saw a larger number of images. When he opened the angle, he saw fewer.



After experimenting with the mirrors, he built them into an optical device by fastening them into a permanent V and inserting them into a tube. He covered one end of the tube with a disc. The other end was left open. He made a small hole in the disc in order to look through the tube. When he peered through the hole at anything, he saw six images converging on the center of his field of vision.



Brewster thought his instrument would make a wonderful toy. He called it a kaleidoscope, from the Greek root *kalos* (beautiful), *eibos* (form), and *skopio* (to see). Brewster was right; the toy was an instant success. Over 200,000 were sold in London and Paris within the first three months.

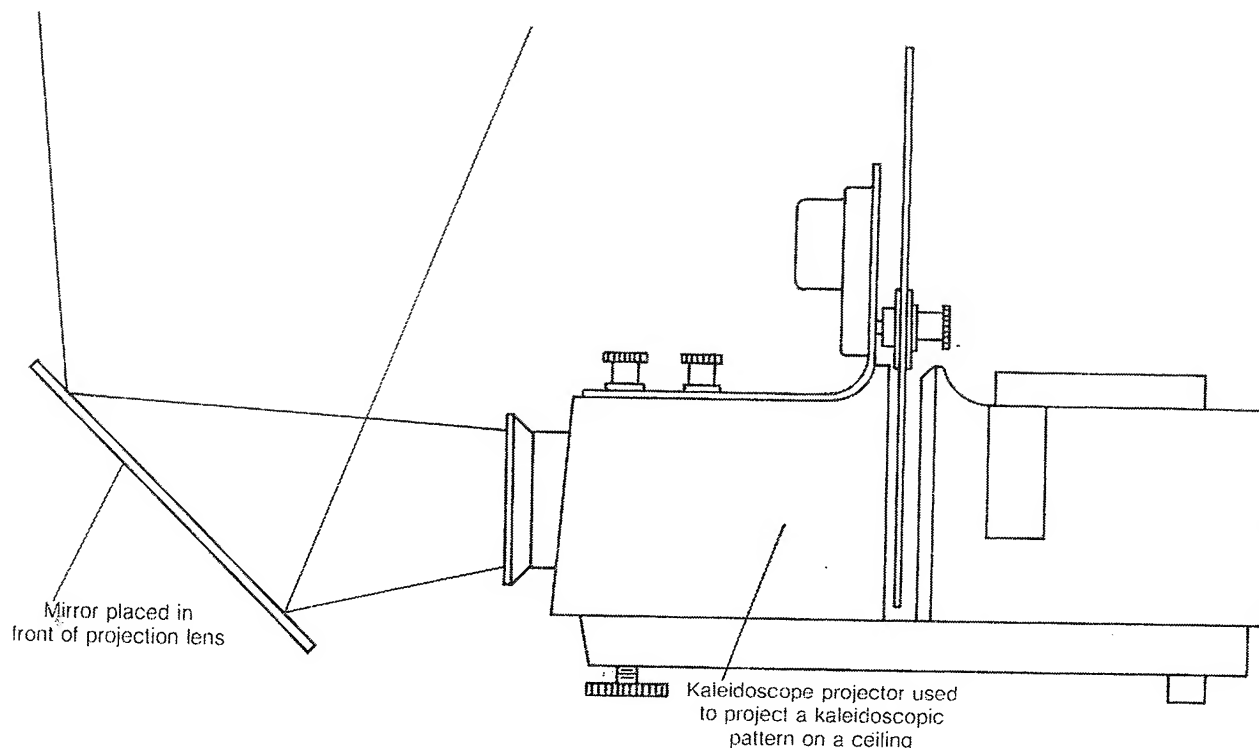
Some purchasers of these kaleidoscopes made improvements on Brewster's idea. They put pictures and designs on the open end of the kaleidoscope. Some added small, colored pebbles inside a hollow disc opposite the viewer's end of the tube. This hollow disc was made of a material that let light pass through. If too little light is allowed to pass through, the viewer will not be able to see anything in the tube but darkness. This hollow disc type with a light transmitting end is what most kaleidoscopes are like today.

With the advent of light projection devices, the kaleidoscope underwent its next major improvement. Kaleidoscope projectors (or kaleidoramans, as some people like to call them) began to appear in the early 1870's. Initially, these instruments used old magic lantern optics to project their kaleidoscopic images on walls and ceilings.

As projection systems got better, so did kaleidoscope projectors. They began to appear at fairs and movie theaters. Today, the motion picture industry sometimes uses them as colorful backgrounds for movie titles. Now there are special kaleidoscopic lenses available for projection. Developed by Edmund Scientific Co., these give you the beauty and versatility of much more expensive projectors. There are details on the kaleidoscopic lens on page . Used in conjunction with a motorized special effects disc, you can get a magnificent variety of colorful effects.

Kaleidoscope projectors can be excellent decorating devices. Used in the home, discotheques, light shows, store displays, or trade shows, they never fail to capture and hold attention with beautiful, changing color images.

Until now, kaleidoscope projectors have been custom made or complicated machines, often very high-priced. This has limited their commercial usage and virtually prohibited their use in homes, at parties, and in many light shows.



Project On People

In the theater or discotheque, you can use a kaleidoscope projector instead of a spotlight. Project its unique patterns on go-go dancers, combos, actors, or any performer. This unusual type of spotlight will certainly add a novel effect to the show.

Project On Ceiling And Walls

A colorful, gliding kaleidoscopic pattern on your ceiling, as well as your walls, gives you a "surrounded by light" feeling. This kaleidoscopic environment isn't hard to achieve. It requires three or four kaleidoscope projectors. To project on the ceiling, you don't need to tilt the projector. Instead, just place a mirror in front of the projection lens. Adjust the mirror until the image is at the desired spot on the ceiling.

Project On Balloons

Huge weather balloons hung from the ceiling make excellent screens for kaleidoscopic images. When fully inflated, these balloons serve as front and rear projection screens. The kaleidoscopic patterns cover the projector side of the balloon and go right through it to cover the other side also. You can projection-paint two sides of the balloon with just one projector.

Use Your Products As Screens

The hundreds of machines and products at an average trade show add up to a ho-hum afternoon for many patrons. But your kaleidoscopized exhibit can pull them in and wake them up.

Imagine your display of products with kaleidoscopic

images changing in color all over it. Your products will certainly be seen in a different light. Even just one kaleidoscopic pattern projected over, under, or using your company name or logo will make it stick in the minds of the viewers.

For example, the dry kaleidoscope effect uses a glass disc painted with bright, transparent paint in many colorful designs and shapes. As the wheel turns inside the special effects projector gate, moving kaleidoscopic patterns are projected. These patterns repeat each minute as the wheel revolves but the repetition is not noticeable.

Another "thematic" effect can be achieved by making stencils of a word or picture on a clear disc. Depending on the positioning of the kaleidoscopic lens, the word will appear to grow out from the center of the screen, grow in towards the center, or go around in an angular circle. See page 21.

A Kaleidoscope Color Organ

At first thought, a kaleidoscope projector and a color organ don't seem very compatible, but they are. Connect the lamps of kaleidoscope projectors to each channel of a 3 or 4-channel color organs. Be sure the color organ channels can handle the wattage. Aim the projectors all at the same spot on the screen. When the audio signals received by the color organ trigger the projector, the screen will come alive with changing, blinking kaleidoscopic patterns that pulsate with the music. You can control the color by making your own kaleidoscope wheels composed of varying tones of one or two colors. Each kaleidoscope projector should have a different set of colors.

Polarized Kaleidoscope Projector

It's very easy to convert to a polarized kaleidoscope projector. Just substitute a disc with birefringent material and polarizing material for the kaleidoscope wheel. Then add a polarizing spinner in front of the projector lens. Refer to Chapter 14 for more information on polarization.

The blinking, changing, polarized image, when coupled with the wonder of a kaleidoscopic pattern, really gives you a fascinating and colorful screen image. How-

ever, there is a loss of image brightness because the polarizing and kaleidoscopic apparatus reduce the amount of light reaching the screen. Because of this dim screen image, a polarized kaleidoscope should only be used in a dark room. Also, the closer the projector is to the screen, the better the screen image will be.

The hexidoscope accessory is similar to a kaleidoscope, but more. It has 6 front-surface mirrors that reflect the light in even more patterns.

Chapter 8

"LUMIA"

Did you ever look into a distorted mirror in a carnival fun house? Sure you did--and you probably got quite a chuckle out of what the mirror did to your reflection. It probably stretched your chest, widened your stomach, and distorted your face. Lumia does to a beam of light what that fun house mirror did to your reflection. It stretches, warps and distorts light until it appears shapeless. A beam reflected off a distorted fun house mirror floats by you like a cloud of smoke, a wispy wraith-like ghost of the original projected image.

This is lumia, pseudo shapes moving across screens or walls to fascinate you and your audience. You may use it as an adjunct to your light show performance or, like so many lighting effects mentioned in this book, as a light show by itself. Before building your lumia apparatus you'll probably want to give yourself a preview of the effects.

Purchase a sheet of mirrored film and then train a light source on it such as your 35mm projector or even an ordinary flashlight or spotlight. Reflect the light striking the mirrored film onto a screen. Then, begin rippling the mirror film and watch the reflected image. What you see will be lumia.

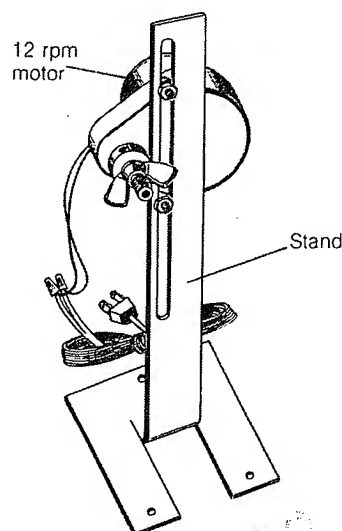
Lumia Reflector

Now begin building the reflector, your major piece of lumia apparatus. Take the mirrored film you purchased and cut out the largest possible disc. Next, cut a cardboard disc the same size and paste or staple the film to the cardboard. Now, hold the flame of a match or cigarette lighter an inch or so below the disc and move it all over the mirrored surface in order to wrinkle and curl it. Be careful not to burn the foil. After you've heated a sizable portion of the mirrored surface, hold the disc up to your face.

Once again you're looking into a fun house mirror. The foil has been heated enough when your image is distorted beyond recognition. Next, mount the mirrored disc on a 12 rpm motor and stand, similar to the one shown in the illustration, and start the disc rotating.

Place a colored slide in your 35mm projector and beam it onto the lumia wheel. Look around you at the lumia reflecting off the warped wheel. As you bring your projector into the sharpest possible focus, the images will take on the quality of rippling liquid.

Defocus the projector and the images become wispy clouds of light.



Changing Color Lumia

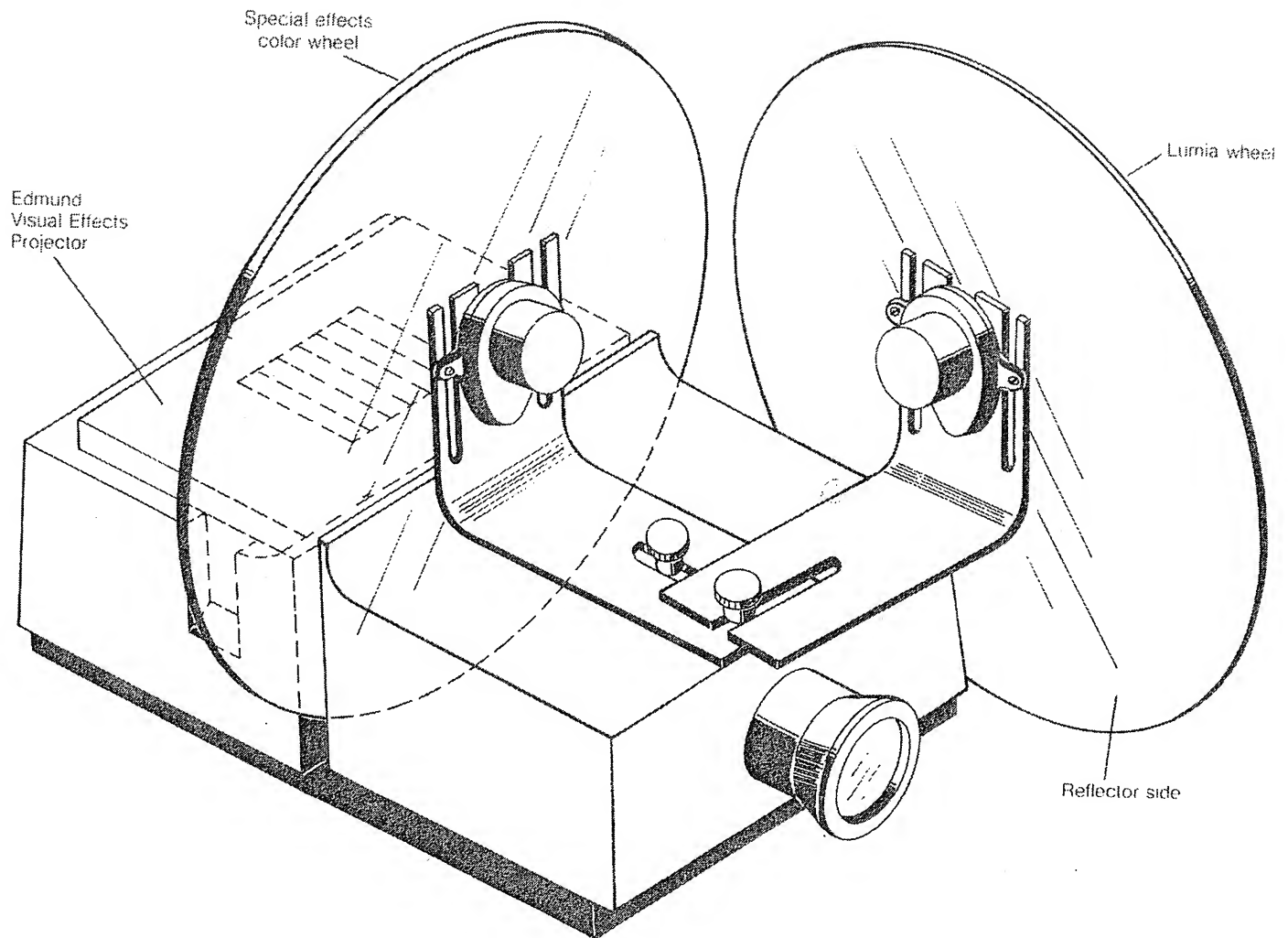
To make the wisps of lumia change color, use a color wheel and rotate it in front of a projector or spotlight. Random patterned or crazy quilt color wheels are preferable to the pie-wedge type for this application (Read Chapter 7 for other color wheel applications). Color wheels rotating at different speeds make lumia all the more interesting. If you wish to handle the source as a unit, a color wheel rotating in an Edmund Visual Effects Projector, (see Chapter 1) will give you excellent lumia color.

Adapting a Visual Effects Projector to Lumia

A visual effects projector can easily be converted into a self-contained lumia unit. Begin by mounting a special effect wheel in the gate of the projector. Use an "L" bracket and motor to make the wheel rotate at about 12 rpm.

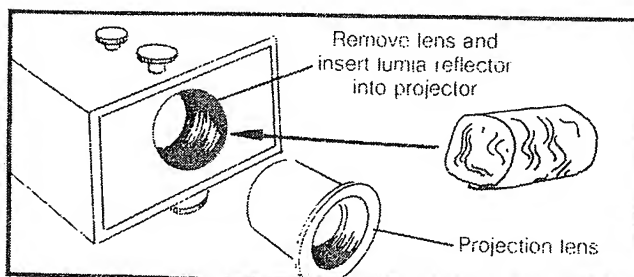
Next, take a second "L" bracket, normally used to mount a color wheel, and place it on the first mounting stud of the Edmund Visual Effects Projector. Turn the bracket to one side as shown in the illustration and mount a 9" dia. lumia wheel on this bracket. The reflective film should face the projection lens so that it can reflect the beam. Start the lumia wheel rotating on the bracket.

Turn on the projector and start the color wheel rotating. Lumia will appear on the wall to the right or left of the projector. Don't turn the wheel directly in front of the projector lens but angle it to the right or left. Look for a circle of color made by the projector beam on the lumia wheel. When you see a full circle on the wheel, the equipment is properly aligned.



Direct Projection Lumia

Here is another method for converting a visual effects projector into a lumia unit. Keep the special effects wheel rotating inside the projector gate. Remove the projection lens from the front and replace it with rolled up mirrored film. The fire ball on the screen will fascinate both you and your audience. If you squeeze the roll of film first, this will make the image change shape. A colored cloud accessory enhances this effect.



Lumia Light Box

This application is discussed in Chapter 12 on Light Boxes. The boxes themselves can be small, portable units or wall sized models containing two or four colored spotlights. They can even be made with cross-ribbed lenticular screens in front, spreading the image into a two dimensional array. Commercially built lumia boxes are available for as little as \$30.00, or as much as \$5,000.00.

Lumia with a Color Organ

Connect a series of dichroic spotlights to a color organ and aim these lights at the lumia wheel from several different angles. Lumia will seem to move with the music. For additional information regarding color organs see Chapter 5.

Lumia Using Other Reflective Devices

Lumia is most often used with melted and warped reflecting film such as aluminized plastic, or aluminized Mylar[®], but you can experiment with solid reflectors to give you lumia variety. You may even wish to try pieces of shattered automobile head lamps or dented hub caps as lumia reflectors.

Chapter 9

LASERS AND HOLOGRAMS

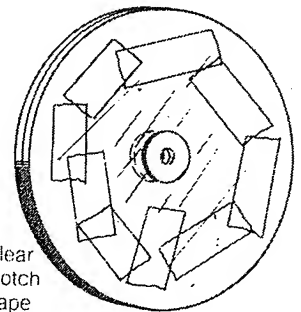
Lasers are the new thing in light shows. Care must be taken while working with them: a laser is a potent, scientific tool and mustn't be dealt with casually.

"Laser" is an acronym for Light Amplification by Stimulated Emission of Radiation. The light from a laser has four unique qualities: intensity, directionality, coherence and bandwidth. That is why laser light is called "pure" light: laser light is of the same wavelength and the waves in the beam are in "phase" with one another. These properties are what make lasers so exciting to work with but are also why they can be dangerous when not handled properly.

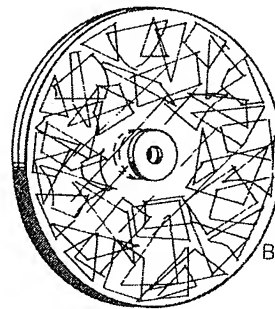
At this point, lasers are expensive enough that not a lot has been done with them in general light show use. Iannis Xenakis evolved a very effective laser light show in Paris in the late 60's. Several other light sculptors have displayed Laserium shows at Planetaria. And there are a few light shows incorporating lasers which are now coming on the market.

If you have access to a laser - and as with most things, prices on Helium-Neon lasers are beginning to spiral down - you might want to try a few light show experiments yourself. A plastic disc, warped as in the chapter on Lumia, and set in front of a low power laser on a 1 to 4 rpm motor gives a billowing effect. Ground glass or Duco[®] cement on a wheel are other interesting possibilities. You might try projecting onto a screen through a fog produced by dry ice or a fog machine.

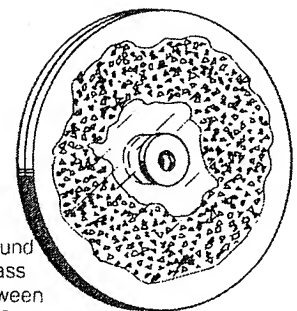
You can aim a laser at a series of small mirrors, placing them at angles so they reflect the light in a specific path and, again, make the path of the light visible with a fog of some sort. If you are showing these effects to friends, be sure that no one is in a line of sight with the light. There are lasers with low enough power or diffuse enough light not to hurt eye tissue but don't try yours out to check a manufacturer's claim.



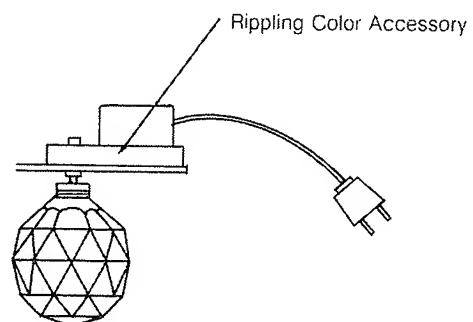
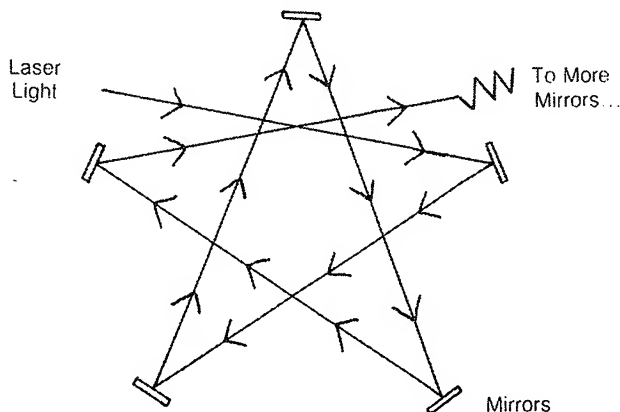
Clear
Scotch
Tape



Mylar
Between
Two
Discs

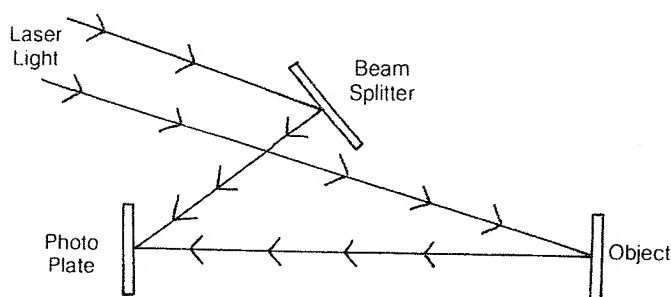


Ground
Glass
Between
Two Discs



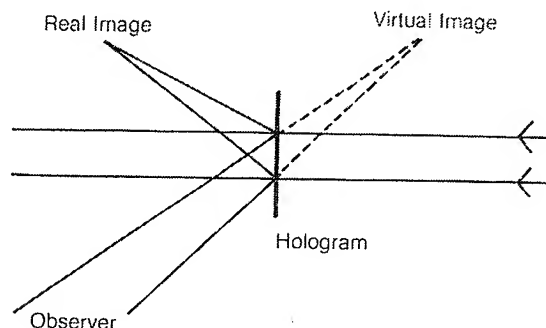
HOLOGRAMS

If you have worked with lasers at school, you probably know a holograph is a picture taken with a laser light source. Dennis Gabor, a Hungarian-born scientist, invented holography in 1948. He coined the word from the Greek *holos* meaning "whole" and *gram* meaning "message": a hologram carries an entire message on one plate. A hologram is produced when a beam of light from a laser is split before it hits the object it's aimed at. Part of the beam is directed at the object and part of the beam is aimed directly at the photographic plate. The light on the plate comes from both the object and the re-directed beam. The emulsion plate records the interference pattern of the two beams. Now, because the light source is a laser and laser light is in phase with itself or is coherent, the emulsion plate records not only the intensity and color of the object being photographed, but also the relative phases of the light and that record of interference on the plate gives us the hologram.



A hologram doesn't look like much: it just shows complex patterns of light and dark where the phases either compliment or cancel each other. To appreciate a hologram, we must reconstruct the process in which it was made but do it in reverse. We must shine a laser light back through the photographic negative. Most of the light passes through the hologram but some is diffracted by the images on the plate. The diffraction of the light ex-

actly replicates the conditions under which the hologram was taken and, by looking past the negative we see a virtual image of what was "holographed." At position R on the diagram, a real image is projected which can be photographed with a normal camera and which will produce a picture of the original object just as if you'd taken a snapshot of the thing itself!



There are actually different kinds of holograms: transmission and reflection. A transmission hologram is illuminated from behind, and a reflection hologram is illuminated from in front. There are also different kinds of images that result from holography: virtual, image plane and real image. A virtual image is one which seems to be behind the holographic plate. An image plane seems to surround the surface of a hologram. A real image is one which appears to be in front of the hologram. There are variations within these categories too, depending on whether or not you use conventional or laser light sources.

There are several holography kits on the market just now and you don't need a laser for all of them. Edmund Scientific markets a number of kits in a wide range of prices. There aren't any which can be used as an active part of your light show just now, but they can lend to the atmosphere of your production and, if you can afford it, the equipment is available for you to take your own holograms of objects that are relevant to your subject.

STROBES

Scintillating stroboscopic light can be a lively, exciting element in any light show, discotheque, or party. Strobes can provide an intensely bright flash of light that lasts for a few thousandths of a second. This flash repeats over and over and seems to stop or break up motion into herky-jerky movements. Some industrial and scientific strobes flash several thousand times a second. These are used to measure motor speed and in motion analysis. More useful for decorative lighting are the entertainment strobes which generally have flash rates of from 1 to 15 flashes per second. Entertainment strobes come in three varieties. . .electronic, mechanical, and fluorescent.

ELECTRONIC STROBES

The electronic strobe usually consists of four basic elements: a Xenon-filled gas tube, a power supply, a capacitor, and an adjustable oscillator-trigger circuit. The power supply charges the capacitor, which is connected across the tube. The oscillator-trigger circuit ionizes the gas in the tube, rendering it conductive. The energy stored in the capacitor then discharges through the tube, causing a brilliant white flash. The process takes a fraction of a second and is repeated again and again.

MECHANICAL STROBES

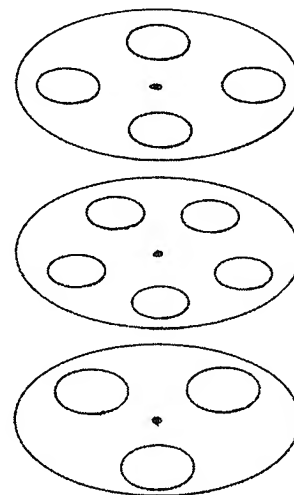
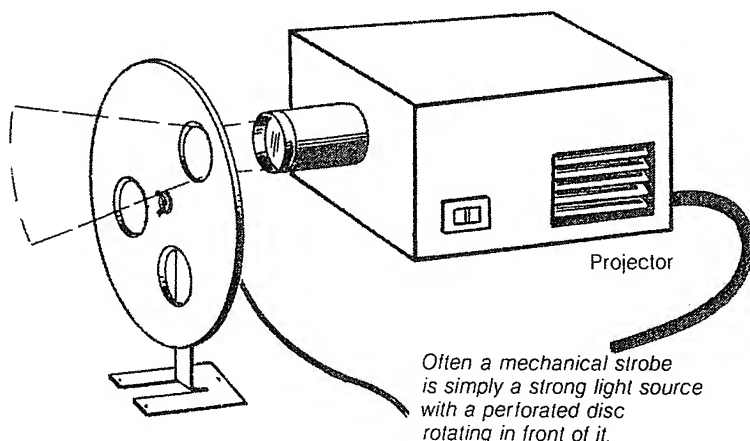
The mechanical strobe operates on a totally different principle. The light source is continually energized, but it's blocked by some interfering object placed in front. You can create a mechanical strobe effect by moving a

card up and down in front of a small spotlight. Often a mechanical strobe is little more than a spotlight with a perforated disc rotating in front of it. The flash comes when a hole in the disc passes in front of the light source.

Mechanical strobes can be made at home with a minimum of expense. Start with a high-intensity light source. A 35mm projector will do. Now, cut holes at regular intervals in an aluminum, wood, or cardboard disc. You may want to perforate an old long-playing phonograph record. The more holes you drill, the faster the flash rate. Just be sure to match the diameter of the holes to that of your light source. Also be sure that the spaces between the holes are at least as large as the holes themselves.

Varying the Flash Rate

Paint the disc black on both sides and mount it on a motor shaft. You may want to keep several discs on hand with varying numbers of holes for varying flash rates. You can also control the flash rate of your mechanical strobe by changing motors, or by using a variable-speed motor to freeze motion for a "silent movie" effect.



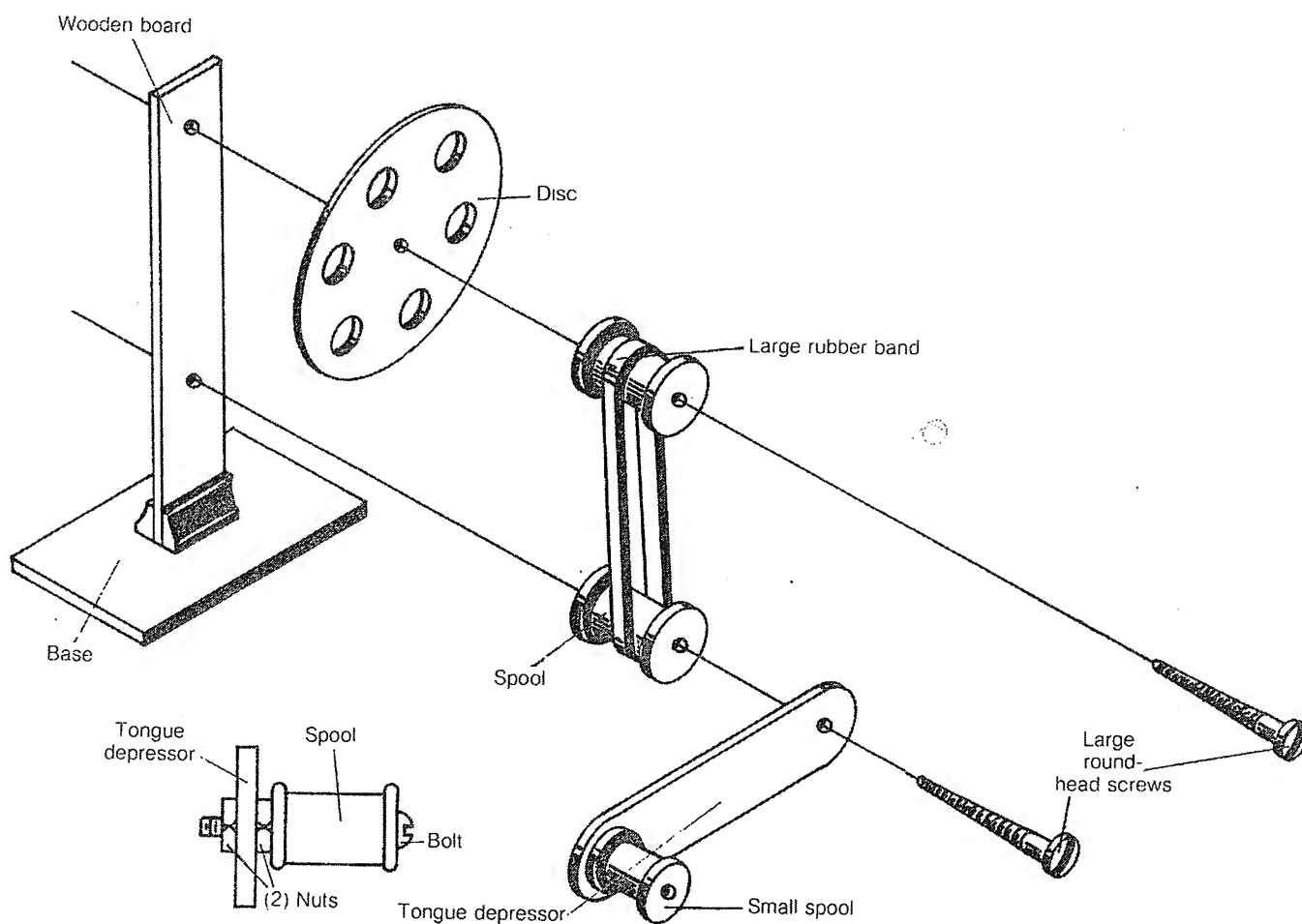
Several discs with varying numbers of holes.

BUILD YOUR OWN MANUAL STROBE

To build your own manual strobe you'll need: a tongue depressor, three empty thread spools (one smaller than the other two), two 1" thick boards, two round-head wood screws, one machine bolt with two nuts, a thick rubber band or a strip of rubber cut from an inner tube, a perforated metal or cardboard disc, two pieces of molding, and wood cement.

First, cement the perforated disc to one of the large thread spools. Then, cement the other large spool to the tongue depressor. Fasten the small spool to the oppo-

site end of the tongue depressor as shown in the illustration. Cement the two board sections at a 90° angle and add molding. Now, using round-head screws, fasten both spools to the vertical board section. Connect the spools with a rubber band or a strip of inner tube and you have a hand-cranked strobe. Position the manual strobe in front of your light source (a 35mm projector is ideal). Make sure that the light source is as close as possible to one of the holes in the manual strobe disc. Turn on the light, turn the crank, and strobe away.



CRANK DETAIL

ESTIMATE YOUR OWN FLASH RATE

If you know the number of holes in your perforated disc and the speed of your motor, you may need some system for figuring the flash rate.

First of all, count the holes in your disc. Let's say there are five. Next, determine the speed of your motor in revolutions per minute. Let's say this motor is 120 RPM. Now, by multiplying the number of holes in the disc by the RPM of the motor you'll have your flash rate in flashes per minute.

$$5 \times 120 = 600$$

But you want your answer in flashes per second. So divide your flashes per minute by 60, the number in a minute.

$$\frac{(5 \times 120)}{60} = \frac{600}{60} = 10$$

Your answer is ten flashes per second, and your formula is:

$$\frac{\text{Number of Holes} \times \text{Motor Speed (RPM)}}{60 \text{ (Seconds/Minute)}} = \text{Flash Rate (flashes/second)}$$

Now, let's suppose you start with a pre-determined flash rate and you already know the speed of your motor. You'll probably want to know how many holes to drill. Simply rearrange the formula.

$$\frac{\text{Flash Rate (Flashes/Second)} \times 60 \text{ (Seconds/Minute)}}{\text{Motor Speed (RPM)}} = \text{Number of Holes}$$

$$\frac{60 \times 10}{120} = H \text{ (number of holes), } \frac{600}{120} = H, 5 = H$$

Your answer is 5 holes.

FLUORESCENT STROBES

Fluorescent strobes can also be used to create interesting lighting effects in light shows and discotheques. The big drawback with a fluorescent flickerer is that action is not stopped as well as it is with electronic and some mechanical strobes. This is due to a fluorescent unit's longer flash duration. This drawback is more than overcome by the many advantages of fluorescent strobes. They provide wide illumination covering large areas of dance floors, seating areas, and stages. They are easily converted to black light. Just insert a black-light tube. They aren't as expensive as electronic strobes and their maintenance and tube replacement costs are low. And there aren't many of them around. This gives you a novel addition to your light show or displays.

STROBE COMPARISON CHART

	Electronic	Mechanical	Fluorescent
Cost	highest	lowest	middle
Lamp life	shortest	varies	longest
Lamp Replacement Cost	highest	varies	lowest
Flash Rate Adjustment	best: fastest, highest range	worst: determined by disc and motor speed	fair amount
Size	smallest	big and fat	long and narrow
Adding Color	place color filter over reflector	easiest; put color filters over holes in disc	hardest; add long strips of color filter to tubes
Conversion to Black Light	fair: Xenon lamps provide some ultraviolet. Use blacklight filter 3-16.	poor: mechanical strobes usually use incandescent lamps which have little or no ultraviolet.	easiest: just use blacklight tube

The Flickering Fascinator

Stroboscopic light has a limitless capacity for enthralling its watchers. At certain speeds, it appears to freeze motion for a "silent movie" effect. At others, it provides a rhythmic light accompaniment to fast-moving music. Some observers complain that strobes cause vertigo, disorientation, even nausea. Most people experience no discomfort. Instead, they stare, fascinated, at some "strobed" object. Very little has been established about the psychological effects of strobe light. The field is open for your personal experimentation. You may want to play catch under a strobe light with a beach ball or balloon. The light will seem to slow down the motion of the object you're throwing or catching. Try activating several strobes synchronously, then asynchronously, at varying speeds, and test your reactions.

Stroboscopic light offers enormous home entertainment potential. Strobe your cocktail parties to fascinate your guests. Train the strobe on your favorite paintings to add a new dimension to art appreciation. The best flash-lit subjects are those in motion. The motions of spinning, spoked wheels and fans "freeze" under strobe lighting. To do this the strobe must be blinking at the same speed as the spinning object or a multiple of that speed (1, 2, 3, or more times faster). Here the effect is hardly diminished in a fully lit room. Motorized, junk sculpture makes an excellent strobe target too. The swinging, gyrating objects seem to become part of a silent film.

Strobing store window displays can double their effectiveness. You can paint discs and set them spinning under strobe lighting for an attention-getter. Some whirling designs seem to change shape under the flickering light.

Stroboscopic light also has enormous potential in the field of experimental theatre. Light flashes can vary in speed and intensity with the intensity of the dialogue and drama. Whole scenes can be played under strobes for a unique psychological experience for audience and actors alike. Imagine a full ballet conducted under stroboscopic light! A slow-flashing light can accompany the loudest noises in your sound inventory. A single strobe flash can precede thunder for exciting stage realism.

Like black light, strobes seem most at home in the discotheque. Incidentally, here is where the strobe and black light form an excellent partnership. By placing a rotating, perforated disc in front of your ultraviolet light source, you can turn it into a mechanical, black light strobe. Or, you can place an ultraviolet filter in front of a xenon strobe unit. For the best black light shows, play your black light strobes on fluorescent objects in motion. For interesting effects, play one black-light strobe and one conventional strobe on the same moving fluores-

cent subject. Set the black light strobe at a high flash rate and the conventional strobe at a low one. Note how the flash of conventional light adds a counterpoint to the rhythmic, black-light flicker. For a sweeping light effect, surround the room with strobes sequenced to flash one after the other. The strobes can be activated by a manually operated row of buttons, a motor-driven switch, or a ring counter.

The subjects suitable for strobing in a discotheque are too many to mention here. You can strobe pulsation-pumped fountains and apparently freeze the drops of water in mid-air. You can strobe a moving pendulum. Or, twirl beads in the air under a strobe. High-speed strobes can scan the dance floor or be trained on performing dancers. Fill your room with flickering bubbles by training the strobe on a bubble machine. The possibilities are endless.

DON'T MIX LIGHTS

Only on rare occasions do strobes and room light mix. The lights can be on when strobing a spinning object. Here the brilliant flashes still offer some contrast to the dull room light. As a general rule of thumb, however, the strobe should be used in total darkness for maximum black/white contrast. Before activating your strobes, turn the house lights all the way down. Seal up all light-leaking cracks. The stroboscopic flashes will appear all the brighter.

WHICH STROBE WHERE?

Commercial xenon and mechanical strobes are available in a large variety of intensities. A rule of thumb is necessary to help decide which strobe will perform best in what size room.

Generally, a 40 to 60 watt-second strobe will be more than enough to flash-light a normal size room. Strobes of this intensity are not very expensive and are recommended for home use. A strobe of this size will also provide more than enough flash for a store window display.

The somewhat larger 120 to 140 watt-second strobes are more adaptable to theater lighting. Placed just off stage, these strobes can flash-light not only the stage but the first ten rows of the theater.

For the large discotheque a strobe of at least 200 watt-seconds is required. Such a strobe will light a 60 to 80-foot dance floor. If the floor is larger, several 200 watt-second strobes, operating in unison, may be necessary to light the area.

BLACK LIGHT

The colors we can see make up the "visible spectrum." They range from red through orange, yellow, green and blue to violet—the colors of the rainbow. Violet is where the visible spectrum ends and an invisible spectrum begins.

Black light is so called because it isn't visible to the naked eye. In fact, a black light source is emitting ultraviolet waves which are shorter than those in the visible spectrum. The sun is a source of ultraviolet light.

Ultraviolet light has different wavelengths like the visible spectrum colors. 1) Far ultraviolet light (or short-wave) is used in chemical research and medicine. . . it can kill bacteria. Exposure to this for any length of time can cause eye and skin damage. 2) Infra-red light (medium wavelength) causes suntans. . . too much can

cause sunburn. 3) Finally, harmless near-ultra-violet light (or long-wave), commonly called black light.

When ultra violet rays are shined onto fluorescent materials, the rays excite the electrons of the fluorescent materials and the energy from those electrons is emitted in the form of light or fluorescent "glow." The glow stops when the light is turned off and the rays are no longer bombarding the electrons.

Over 3000 known substances will glow when exposed to black light and many of these have been incorporated into paints, crayons, chalk, pencils, dyes, fabrics, tapes and strings. Some materials appear to be one color in visible light and another under black light. Some aren't visible at all until they're exposed to ultraviolet rays.

Using a black light source and some fluorescent materials, you can create a range of special effects to incorporate into a slide show, a theatrical work, at a party or in your own home.

Black lights come in two general forms: a purple light bulb which screws into any normal socket; and a fluorescent tube. The tube is much more effective in creating effects. As with any other light source, fluorescent tubing emits about four times as much light per watt as an incandescent. Tubes are also safer since they perform at lower temperatures than bulbs.

With a little imagination and some fluorescent paints, chalks, tapes or whatever, you can create magnificent and surprising effects. Paint pingpong balls and paddles for an eerie game of table tennis; paint "invisible" messages on walls and reveal them at the flick of a switch; sprinkle clothing with fluorescent dust - made by crushing fluorescent chalk; the applications are only as limited as your fund of ideas.

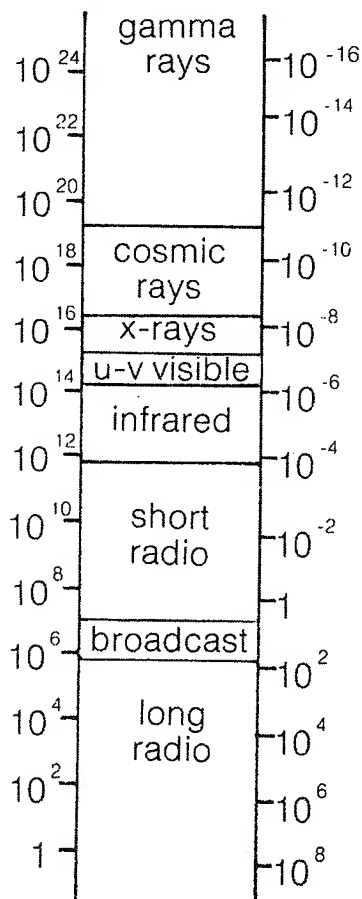
As you read through this book, you may find some other categories of special effects which can be enhanced with black light.

Black light has practical uses, too. Fluorescence is often used at "pass-out stations" where a person's hand is stamped for security reasons. It's an excellent way to identify people invisibly without their being able to transfer the identification.

Invisible laundry marks are now used in many laundries and are highly desirable because no black marks are left on finished work. The invisible marks are quickly and easily seen under black light.

Veterinarians use black light to fluoresce common ringworm in dogs and cats.

Frequency **Wave Length**



Fluorescent dye tablets are used by engineers and ecologists for water pollution control, stream tracing, leak detection, and sea markings. To chart the course of an underground stream, biodegradable dye tablets are dumped in the stream at a point above ground. By checking with a portable black light at different places where the stream reappears you can tell how streams interconnect and how fast the stream is moving.

Sales personnel, store managers, anyone working at a cash register, as well as police detectives, can quickly and easily detect counterfeit bills with a black light. Most counterfeit bills will fluoresce under black light. Just tape

a normal dollar bill under a black light for comparison purposes.

Philatelists (stamp collectors) use black light to detect water marks, fluorescent overprints, postmarks that have been removed, repairs, forgeries, etc.

Many "rock hounds" use black light to make attractive displays of the fluorescent minerals in their collection. A portable black light can be used on location to discover fluorescent minerals, some valuable ores, and even natural oil.

These are only a few of the practical uses for black light. More uses are being found every day and yours can be as exciting as any of these.

LIGHT BOXES

It's one thing to see a fascinating light show, and quite another to stage one yourself. If you get the urge, one of the best ways to start is by constructing a light box. It can be as simple or as fancy as your ingenuity can make it.

Here are some ideas for making your light show happen in a box small enough so you can carry it around. . . your own portable light show. All you really need to get it off the ground is a wood, metal, or even cardboard box, some blinking lights, and a screen.

The technique is simple. The lights, common indoor Christmas tree lights usually of the blinking variety, are arranged in the back of the box with a power cord leading out the rear. Mount a rear-projection screen over the open front of the box. Plug it in and you have a simple light box.

Light Boxes

The advantages and disadvantages of light boxes are obvious. In a box you can build a light show in one unit that can be set up virtually anywhere, plugged in, and displayed. Against it, you are limited in size by the very fact that your light show is boxed.

Four basic ingredients go into the making of a light box: lights or light sources, the box itself, a screen, and sometimes a mask. Any combination of these will give you a pretty good light box. Selecting the right lights, matching them with the best screen, and using an interesting mask will give you an excellent light box, and give it to you at no more trouble or expense than constructing an indifferent display.

Consider the types of screens, boxes, masks, and lights that are available.

Screens For Light Boxes

Screens, in general, have been discussed in Section 8, but light box screens are a bit more specialized.

Only rear-projection screens can be used in light boxes. Rear-projection screens are designed to be projected through and so transmit more light than they reflect (compared with the more common front projection screens which are designed to reflect light from a source on the same side of the screen as the viewer).

Rigid rear-projection screens are commonly used in light boxes although there are uses for the flexible types as well. A 20" x 24" rear-projection screen is most useful for building large light boxes. Ground glass screens and

Eastman Kodak coated glass rear-projection screens can also be used. So can flexible thermoplastic sheeting or Lenscreen® sheets. With a flexible screen, you are not restricted to flat use. Sometimes putting waves in a flexible screen will produce interesting effects. Chapter 13 gives additional information on the light diffusing characteristics of rear-projection screens.

Translucent lenticular screens are made up of many fine lines, and unlike the lenticular screens used for front projection, will shape light as well as diffuse it. A single lenticular screen gives you a linear pattern. . . a colored line for each colored light in the box. Crossed lenticular screens will shape these lines of light into overlapping squares, diamonds, or intersecting lines depending on the angle at which the lenticular lines of the two screens are crossed.

Patterned plastic sheets, like transparent lenticular screening, will also shape light. The patterned plastic used in room dividers can convert flashes of light into starbursts, radiating bull's-eyes, or simple wraith-like forms suggesting circles. Patterned plastic sheets are relatively inexpensive, and come in many colors that can be used with white lights for effective one-color light boxes.

Light Sources

Colored Christmas tree bulbs that blink probably make the least expensive light sources. Many colors are available, and you can paint or dye clear bulbs any color that you cannot buy commercially. Clear bulbs are superior to frosted ones because they pinpoint the light source, thus casting sharper shadows on the screen. Although each bulb only puts out about 7 watts of light, many will blink on at the same time making the light box much brighter than you might think.

The number of blinkers needed will depend mostly on the size of the light box and on the type of screen. The larger the box, naturally, the more lights you'll want and have physical room to install. The darker the screen, the more lights needed to bring out the color. Lighter colored screens enable you to get by with fewer lights. If you think of changing screens in the same light box, consider installing enough sockets for the darkest one you may use, and then only inserting the number of bulbs needed to make the right brightness for the screen you are using at the moment.

Non-blinking Christmas tree lights can also be used in light boxes. You can modulate them with a color organ. To do this, use several strings of lights and connect one to each channel of the organ. Arrange the bulbs so that all the lights on each string will not be bunched together in one corner of the light box. By crossing and recrossing the two or three strings of lights, you can cause the bulbs to flash alternately, thus making images appear, disappear, and overlap on the screen.

You can also use colored spotlights or dichroics (lights that give a high color purity due to special dichroic interference filters) in your light box. A color organ will make them flash alternately or together and they can be tied in with strings of Christmas tree lights or used alone. A simple flash timing device can cause the lights to project repeated patterns by flashing in sequence.

Light Box Housings

The size and shape you choose for your light box determines whether it is really portable or not. Size also makes the difference between an interesting novelty and a prized addition to your home.

The appearance of the box itself is a matter of style and personal taste. Don't limit yourself to a box shape. Light box housings can be made cylindrical or spherical just as easily as in box form. They can have curved or angled fronts, or even light up both front and back using different screens and masks giving you two different shows in the same box. A musical group might even want to build a show into their bass drum and keep it turned toward the audience. This will be an ideal subject for two-way light boxes.

Any kind of container can house your light box. Toy drums, old cardboard boxes, waste baskets, and dead television sets make good light box housings. Don't limit your imagination. . . far out ideas often work out the best.

Masks

Masks in light boxes are useful but optional. They can change the whole character of the image. Used with straight diffusion screening such as drafting film, plastic shower curtain material, or a rigid rear screen, masking is most effective. Masks generally don't work too well with lenticular or patterned plastic screens.

Shadow masks are the most popular. You can make one by cutting shapes in black construction paper or cardboard and mounting it in the box between the light source and the screen.

The patterns in the mask will appear on the screen in different colors depending on the lights behind the mask. The closer the mask is to the screen, the smaller and sharper is the image. The closer the mask is to the light, the larger and more diffused is the pattern.

Patterned plastic, already suggested as a light shaping screen, also makes an excellent light refracting mask. Bottle-bottom patterned plastic shapes the light into concentric circles of color.

Filter masks color light rather than shape it. Plastic color filter masks color the images from white-light blinkers. Masks made of polarizing material with cellophane tape in front work well to bring out the colors produced by birefringent (double refracting or double image producing) cellophane. A special portion of this section deals with building polarized light boxes.

Light Box Ideas

These four elements. . . lights, screens, masks, and a housing. . . can be combined to build hundreds of different types of light boxes. Here are a few combinations you might want to try:

LIGHT BOX IN A METAL CONTAINER

This is a small light box that you can build cheaply to serve as a piece of novelty furniture. It can be as small as a coffee can, perhaps painted in psychedelic colors and swirls, or a metal waste basket. Or, what have you!

Start construction by making a hole in the bottom of the can for the power cord. Since you will be working with electricity, wiring, flammable substances, and heat, consider general electrical and fire safety when designing your light box. It's a good idea to use a rubber grommet or tape in the hole in the base of the can to keep the power cord from chafing or shorting out. Think about what heat may do to the material you are considering for masks and screens. Are they flammable? Will the heat of the lamps distort any plastic to be used as mask or screen? Do you care particularly if the shapes change? Will cellophane tape or other tapes used to hold things in place stand up to the job? Or, are you building yourself an indoor fire bomb? Think first and avoid a dangerous light box or one that will not last very long.

Having prepared the container and arranged Christmas tree lights inside it, the next step is to mount the screen and perhaps a mask. Self-blinking Christmas tree lights give action to your light box, or it can be activated by a color organ. For a small, simple light box of the coffee can variety, mount the screen in a cardboard ring that will just fit over the open end of the can. Do this by cutting two such rings, perhaps 3/4 inch wide, stapling a similar sized disc of white drawing tissue, flexible screening, matte white screen, Lenscreen®, or thermoplastic sheeting to cover the opening. Black tape around the outside edge seals the screen in place making the edges light tight. If the hole is cut just the right size, the screen will snap in place over the open end of your light box. The solid discs cut out for making these hoops can be used to make masks. Do this by cutting patterns out of them and inserting them in the can under the screen. A neat, simple, effective screen comes with some kinds of coffee cans. This is the clear or translucent plastic snap-on top intended to preserve the coffee after opening the can.

Your light box can become a low-power projector by simply removing the screen and placing the light box where it can illuminate a wall or ceiling.

ELECTRIC DRUM

This is simply a cylindrical light box with screens on two sides. It is made from a real or toy drum; the translucent drum heads make the screens. Various masks can be cut to size and used in drum light boxes. A general note on light box construction: it will usually improve your results if you make sure there are no light leaks and that any masks used are really opaque. Just as the innards of a good optical instrument are painted flat-black so they will reflect no light, so the interior of your light box should also be sprayed flat-black.

A large electric drum might do well with a musical group. Smaller ones can be hung from the ceiling as party lanterns, or they can just be used as hanging decorations.

STARBURST LIGHT BOX

This is a maskless light box which uses a special screen to shape the light. For a screen, use hexagonal patterned plastic like that frequently used for room dividers. This type of light box is most effective in large sizes. We suggest using at least 20 inch square screen and enclosure.

WRAITH LIGHT BOX

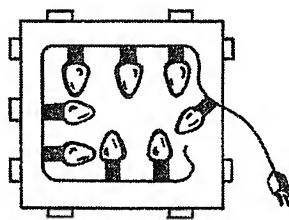
Using patterned plastic as a mask instead of a screen produces wraith-like patterns of light. Be sure the inside of the box is painted flat black. The mask is most effective when placed deep in the box, close to the lights.

LENTICULAR LIGHT BOXES

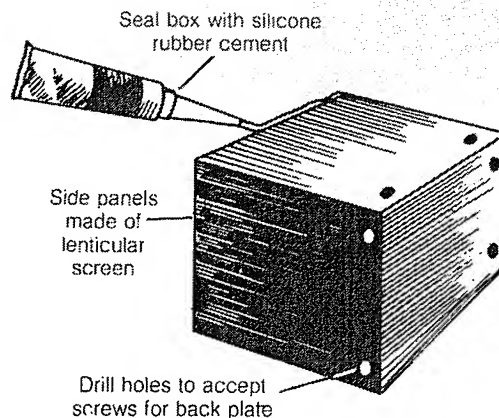
Lenticular screens reshape the light projected onto them in long, thin streaks. Colored bulbs make colored streaks. A neat trick is to paint vertical stripes on clear Christmas tree bulbs with transparent colors. Each bulb will then give you separate streaks on the screen for each color.

For still greater variety, cross the lines of two lenticular screens. Place one screen in front of the other with the lines crossed at right angles. The flashes of colored light will appear as colored squares. Placing the lamps at various distances from the screens gives depth between the squares. Cross the screens at a different angle and you'll see diamonds. Hand painted bulbs make the squares multicolor giving a plaid effect.

Lenticular Cube Light Box



Wooden back plate
wired with Christmas lights
(fits into open end of
light box)



LENTICULAR CUBES

These are light boxes made of lenticular screening on all but one side. Join seven squares or rectangles of lenticular plastic screening, using silicone rubber cement to form a box with one open side. Drill several holes near the edges of the screen by the open side for screws to hold the wooden bottom plate in place. A lenticular light cube can hang from the ceiling or stand on a table. The interior construction is the same as that for any other light box, but it will take a bit of experimentation to find the best pattern for the lights because they will be seen from more than one angle.

COLORED FILTER MASK LIGHT BOXES

Colored filter sheets or gels provide the color in this light box, so you can use clear bulbs. The filter material can stand alone if it is stiff enough. Gels can be taped to window glass masks for support. Use a regular screen in front of the colored mask.

POLARIZED LIGHT BOXES

For this type of light box you will need polarizing material, birefringent material (cellophane, cellophane tape, Mylar) and white Christmas tree lamps. You can make polarized light boxes in many ways; a little experimentation with various arrangements of the materials is suggested. Remember, however, that the birefringent material must be between two sheets of polarizing material and that the lights must be behind the polarizing material. A typical setup is as follows:

Turn two sheets of polarizing material until they transmit no light. Mark them to indicate this position and cut them to the size of your light box housing. Attach cellophane tape or other birefringent material to one side of one of the sheets; you choose the pattern. Place this sheet, with the birefringent material facing front, in the box in front of lights. Place the second sheet of polarizing material in front of the first.

Turn on the lights of the box. The polarizing material will block the light in all areas except where you've attached the birefringent material. In those areas, you will see polarized color surrounded by a black background. . an effect that will remind you of an oriental color etching.

THE LIGHT WALL

This is a giant light box. Make one by taping Christmas lights to a bare wall. Hang a cyclorama cloth screen in front and you have made a whole wall into a light box. Do this for all four walls and ceiling of a room, and you've built yourself into an inside-out, (or perhaps more correctly, outside-in) light box with you in the middle. The effects can be pretty wild.

Two types of shadow masks work well with light walls. Solid masks show repeats of dark images. Masks with shaped holes cut in them produce black framing around colored images. Both are very effective.

ROTATING MASKS FOR LIGHT BOXES

To produce constantly moving images on a light box, use a circular mask which is slowly turned by a geared, or very low speed, synchronous electric motor. The motor can be mounted on a block of wood at the back of the light box, among, or even behind the lights. The mask is mounted on an extension of the motor's shaft. Keep the mask light in weight so it won't overload the front bearing of the motor.

COLOR WHEELS FOR LIGHT BOXES

In these, the rotating mask has its openings covered with colored cellophane or other colored plastic. White lights work best and the color comes from the gels in the rotating mask. If you are using a stationary mask in conjunction with a rotating color wheel, images will appear, disappear, and change colors on the face of your display.

LUMIA LIGHT BOXES

These light boxes produce colorful, wispy patterns on your light box screen. Unlike all other light boxes discussed, this type does not use blinking Christmas tree lights. Instead, four small dichroic spotlights constantly concentrate their beams in the center of the box. The moving light patterns are produced by reflections of curved mirror film mounted on a rotating disc. Bits of broken automobile headlight reflectors are great for this when glued to the disc. The disc should be as far back in the box as practical. Aim the dichroic beams so they will strike different parts of the rotating, multi-mirrored disc, mostly away from the center. Then juggle the lights so the reflections hit the center of the screen, or different parts of it. A border or frame around the screen will hide the spots effectively.

When the wheel turns, fascinating wispy colored patterns will fill your light box screen.

COLOR ORGAN CONTROLLED LIGHT BOXES

Any of these types of light boxes can use a color organ to make the lights flash, instead of the Christmas tree blinkers. For this kind of setup, replace the blinkers with non-blinking colored or plain white bulbs depending upon the type of light box you are "organizing." Use as many strings of lights as you have channels on your color organ. Arrange them so all the lights on each string are not bunched together. The result will be lights that change color to the beat of the music.

SCREENS

So far in this book, we have discussed what and how to project. What to project ON is also important. The projection surface affects the brightness, definition, and the color of the projected image. Therefore, it's worth discussing at some length.

In this discussion, we will divide screens into three groups: conventional or front-projection screens, rear-projection screens, and those screens which can be used for both front and rear projection. A conventional, front-projection screen is used with the audience and the projector on the same side. This type of screen should reflect as much light as possible. A rear-projection screen is used with the audience in front of it and the projector behind it. Rear-projection screens transmit light, but still retain the projection image.

Combination front and rear projection screens show the projection image on both sides of the screen. This image is invariably dim on both sides, although Roscoe Company of Rye, N.Y. has come up with some new and quite successful front/rear materials. The novelty of an image appearing on two sides of the screen is often appreciated, and can sometimes be put to good use in light show presentations.

CONVENTIONAL SCREENS

You can buy a conventional screen in almost any photographic supply store. Some people prefer to make their own. In either case, you will need to know something about the materials available. Here are a few of the most popular types:

Matte White Screens

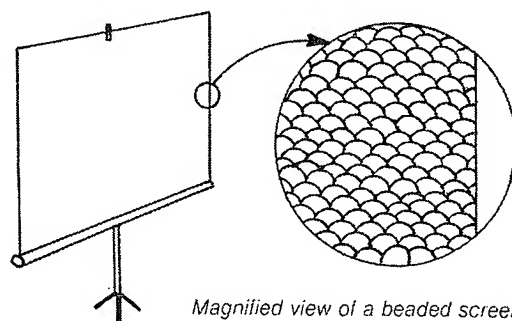
Whether you're buying or building your screen, the matte white screen is the most inexpensive type around. In addition to its price advantage, this type gives the finest screen-image detail. This fact is important to remember if you must have sharp, clearly defined images. However, most light shows don't require the sharp screen details that photographers prefer. In fact, hazy and even poorly defined images are often desired by light show operators.

Although matte white screens give true color (a real plus factor in a wet show) the images shown are not extremely bright. A good deal of light is absorbed by the screen. This doesn't present a problem if you are projecting in a totally dark room. The darker the room, the better the contrast and the better the light show appears on the screen. If the room is not completely dark, a matte screen will give a dim screen image.

Beaded Screens

Beaded screens cost more than matte white screens, but reflect more light and show a much brighter image. A beaded screen is just what the name implies. . . thousands of tiny glass beads coated right on the screen. Each bead acts as a tiny lens and intensifies the reflected image. This image is reasonably sharp and well defined, but not as sharp as matte-white screen images.

Light shows can be projected on beaded screens placed in rooms with some stray light, but not too much light. This is a definite advantage over matte white screens, and very important for light shows because patrons are less likely to trip and injure themselves in a room that has at least a little light. Too much light does affect a beaded screen's performance.



Magnified view of a beaded screen

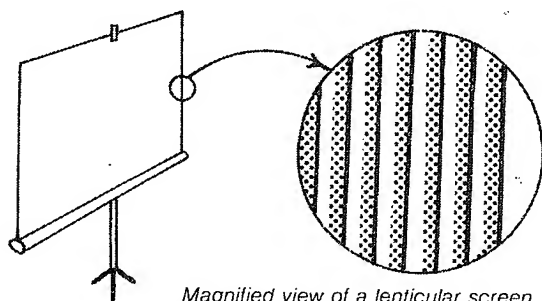
Lenticular Screens

Lenticular (lenslike) screens have a ribbed surface of vinyl or some other plastic material. This ribbed surface is the result of many horizontal and vertical lines molded in the plastic. Usually, the surface is aluminized which makes it silverish in color.

The ribbed, aluminized surface permits a lenticular screen to function something like a sheet loaded with many small concave mirrors that reflect the image. This gives a very bright screen image which is a valuable asset to any light show. Unlike the other screens mentioned, this type performs excellently in areas that cannot be darkened. When used with good projection equipment, a lenticular screen can show a bright projected image even in daylight.

Lenticular screens have several minor disadvantages that haven't interfered with their popularity. They cost more than matte white and beaded screens. They must be stretched fairly tightly when in use because wrinkles show up as variations in image brightness. The lines of the screen can sometimes be noticed by the audience, especially if they sit very close to the screen.

Good color fidelity is obtainable for most colors. Blues and reds are intensified. However, white shows up silver, and yellows appear as gold. This color problem is minor because many viewers either fail to notice or get used to it after a short time.



Low Budget Screens

After checking the prices of the above screens, you might feel that you would rather spend less of nothing at all. If that's the case, try some of these suggestions:

Cyclorama Cloth

This cloth has been used in the theatrical and movie industries for background projection. It's probably the least expensive of the commercial screening materials. Its major disadvantage is that it doesn't reflect very much light. Whether viewed from the front or the rear, the screen image is relatively dim. Because of its low cost, ease of handling, the durability, cyclorama cloth is most useful where huge screens are needed to fill a room with images.

Bed Sheets

Bed sheets are also useful in certain large screen applications. To most people's surprise, bed sheets are more expensive than cyclorama cloth. They are also a little more difficult to work with. You just can't take them off the bed and hang them up. They should be starched and ironed without folding. This helps to keep the wrinkles out.

Walls

If your walls or ceilings are painted white and are free from cracks, chips, and pictures, they might serve quite

well as your screen. Certainly, the price can't be beat and there is never any time lost putting up and taking down the screen.

Balloons

Surplus weather balloons can make very unusual and economical screens. When inflated, their white neoprene surface becomes semi-translucent. Imagine your light show audience looking up at one or two of these balloons hung from the ceiling. Projectors are hitting the balloons with images that are shown on the outside, inside, and back of the balloons. Some of the images will overlap and be bent by the spherical shape of the balloon. It's quite an effect.

REAR PROJECTION SCREENS

Rear-projection screens are those you project through. The audience is on one side and the projector on the other. This type of screen is used mainly as theater backdrops or where space limitations or decor make it impossible or undesirable to keep projectors in front of the screen.

Currently-marketed rear-projection screens fall into two groups: rigid screens that can't be bent or folded, and flexible screens that can. There are certain advantages to both.

Rigid, Rear-Projection Screens

The rigid, rear-projection screen's prime advantage is that it is self-supporting. It doesn't have to be stretched on a frame. Just prop it up or suspend it from the ceiling. It's also durable; it won't tear or wrinkle. It can be scratched, however. In addition, rigid screens cost more than the flexible type. Where a small screen is needed, a rigid rear-projection screen is often the best one for the job; the light box screen is a prime example.

There are a variety of rigid rear-projection screens available in different sizes, styles, and materials: plastic, Fresnel, coated glass, ground glass, etc.

A new rear projection material is currently making an appearance with a dramatic entrance. Called a "Freen®" screen, it is cast out of resins under high pressure and acts like a giant fresnel lens with parallel ridges. Light is dispersed in front of the actual screen surface and is focused on air. Although it's quite expensive — \$75.00 per square foot — it is a valuable tool because ambient light enhances its clarity rather than washing out the image. A picture is as visible in broad daylight as it is in a darkened room even when the light is spilling on the screen from behind!

Flexible Rear-Projection Screens

Flexible rear-projection screens have several advantages. First, they usually cost less. Second, they are available in larger sizes for huge, pitched screens often used in light shows. And finally, they can be rolled up or folded for storage in a much smaller area.

The three most popular types of flexible rear projection screens are Lenscreen®, translucent projection screens, and thermoplastic sheeting. Lenscreen® is a type of flexible, rear-screening material that is com-

posed of light-spreading, transparent microcells. These microcells transmit enough light for the screen to be used in daylight slide presentations. Lenscreen® provides an excellent image, with good contrast and color fidelity. It is one of the more expensive of the rear projection screen materials.

Translucent rear-projection screen material sometimes used as drafting film is considerably less expensive than lenscreen. It doesn't give as bright an image as Lenscreen, but it does provide good color contrast and sharp image definition. These qualities make it useful for projection in a dark room. Its color fidelity is also excellent.

Thermoplastic sheeting offers up to 10,000 tiny, parabolic lenses per square inch. It is priced in about the same range as translucent rear-projection screens and is as useful as Lenscreen® when high light diffusion seems necessary. A screen made from thermoplastic sheeting can be mounted with a wide variety of adhesives and be used as the front of the light boxes. Unfortunately, thermoplastic sheeting provides almost too bright an image for good contrast. Its image definition seems a bit fuzzy but its color fidelity is excellent. Reds and yellows project very brightly and deeply.

FRONT AND REAR PROJECTION SCREENS

As mentioned earlier, this type of screen usually provides a dim screen image on both sides. You should be wary of some manufacturers' claims that their screens are perfect for both front and rear projection. Often, their screens perform poorly for **both** front and rear use.

If you require front and rear projection for a certain application, it would be smart to settle for the cheapest material possible. In that way, you'll at least get what you paid for. Low-cost cyclorama cloth provides an image on both sides, but since it reflects more light than it transmits, the image will be brighter and sharper on the projection side of the screen. A bed sheet will also provide an image on either side. The image again is brighter on the projector side of the sheet.

SCREEN IDEAS...

Total Environmental Envelopment

The classic conception of a screen is a flat surface on which slides or motion pictures are projected. The light show screen often has to be much more than this. The viewer may lose interest in a projection show that only appears in front of him. A light show that is taking place all around him must hold his attention. The viewer has no place to turn. Your light show is his environment, his total environment.

The screen is the key to a total environment light show. Here are a few suggestions for screens that put the viewer into the projection picture.

The Screen Tent

This screen is, for all practical purposes, a tent pitched indoors. Ropes are suspended from the ceiling and walls and attached to some inexpensive screening material such as cyclorama cloth. The screen hangs all around the viewer. Each rope has pulled its screen segment into a different projection surface.

Projectors can be used with a screen tent in various ways. You can place them in the center of the tent, maybe mounted on a rotating stand that will move the images around the tent. Mount them on balconies or shelves outside the tent and project through openings in the tent. Since cyclorama cloth is also a rear projection screen material, you can project on it from the outside of the tent.

The Screen Dome

The screen dome is similar to the screen tent. It also has to be pitched. The screen material is stretched over a frame of bamboo poles.

There are a couple of ways to use screen domes. You can make a very large one and seat your audience inside it. Another way, that's perhaps more practical, is to erect a small screen dome in the center of the room. Place projectors inside it and project different images on different sections of the dome. Your audience will view the dome from the outside. Rear-projection material is a must for this application.

The Screen Tube

This is another version of the total environmental concept. It's made by connecting metal hoops into a tubular frame and covering this frame with cyclorama cloth, sheets, or some other front and rear projection material. The screen tent doesn't have to be as large as a whole room. In fact, it's more effective when used as a side attraction in a light show. Build it to accommodate about 2 to 10 people.

The big thing about a screen tube is that a spectator seems to be more enclosed by it. Its smaller size and round shape envelop the viewer in an environment of quick-changing, colorful scenes. If you want to create a really exciting effect, try to devise a way of zooming the images on the sides of the tube. This makes the sides of the tube appear to close in on the audience.

When using a screen tube, it is usually better to have the projector on the outside. . .unseen by the audience. If front and rear projection material is used, viewers waiting to enter the tube can see the projections from the outside. Hence, the tube advertises itself.

The Boxed Screen

The boxed screen has its origins in the early, learning-box experiments by psychologist B.F. Skinner. A person entered a screen box just large enough for himself. Information to be learned was projected on five sides (four walls and a ceiling). The idea was that if the information was the viewer's environment, he learned it faster and retained it longer.

A large boxed screen can be built for light show use by constructing a cube-shaped frame out of thin-wall electrical conduit or wood and covering this frame with rear-projection screening material. Project your show on the walls and ceiling and your audience will remember it for quite a while.

THE SCENIC BACKDROP

The screen can also be used as a scenic backdrop behind a performing band, dancers, or actors. Behind a rear-projection screen, you might place a series of projectors, color-organ controlled dichroic spotlights (see Chapter 5), or a lumia arrangement (see Chapter 8).

Blinking, Christmas-tree bulbs can be wall mounted on a screen for a backdrop of everchanging colored dots. This backdrop can be set in a theater, a discotheque, or even in your home.

The rear screen can be used in the theater for an instant scenery change. A slide of the surroundings, or a landscape is projected on the rear screen. As the slides change, the scenic backdrop changes also.

A tube screen can also be used as a changing scenic backdrop for theater-in-the-round applications. The tube screen is placed on the round stage. Projectors inside the tube are on a stand which rotates and changes the scenery.

EXHIBITS

Unusual and attention-getting exhibits using lights and screens can add to your light show or decorating success.

Light Boxes

Light boxes make perhaps the most popular screened exhibits. Many people, after seeing one for the first time, make their own light boxes and use them to decorate their homes or bring attention to their products. Chapter 12 contains complete details on their construction and application. For now, a brief description will give you some idea concerning their use.

A light box is a container that encloses a rear-projection screen and either lights or projection equipment. The rear-projection screen is usually a rigid, lenticular type screen. It can be either the top, side, or end of the light box.

Most light boxes contain blinking Christmas lamps. The colors of these lamps are diffused and mixed on the screen. Sometimes a mask is added to give shape to these colored effects.

Screen Sculptures

A large sculpture is made by building a frame using bamboo or thin-wall conduit. This should be irregularly shaped, but with several flat surfaces or facets. Cover it with flexible, front-projection screening material. Motorize it so that it turns, swings, or swivels slowly and smoothly. Then turn on your projector or spotlights and watch the sculpture bend, warp, and break up the images.

Rear Screen Blocks

A versions of this expensive, but highly effective exhibit appeared at Expo 67. Hollow blocks, with front surfaces of rigid rear-projection screening, are arranged in some interesting or representative pattern. Inside each block is a 35mm projector with remote control wires leading to a dimmer panel. A stepping switch or some kind of relay can control the lights or projectors in a predetermined pattern.

Chapter 14

SLIDES

PHOTOGRAPHIC TRANSPARENCIES

Imaginative, trick photography slides can be the basis of a good light show. Try shooting colored, double - exposure slides of two or three subjects; a face, a tree, or a fire hydrant for instance. Double-and triple-exposed slides will give an impressionistic flavor or a hint of reality to your color slide show. Too much reality can take away some of the wonder and excitement of your show depending on the effect you want to achieve.

If you are planning a large-scale light show, you will probably want to shoot and develop slides in considerable bulk. Here are a few facts on costs for you to consider. The 35mm transparency is photographed and developed more inexpensively than any other slide on the market. This is assuming that you already have purchased a camera and accessories. Film and developing costs for Instamatic® transparencies are slightly more expensive. Keep in mind, however, that the price of an Instamatic® camera is considerably less than that of a 35mm camera.

Super slides are much more expensive to process than either Instamatic® or 35mm transparencies. They are often worth this added expense because they provide larger images at shorter projection distances than 35mm or Instamatic®. Instamatic® slides are next in image size; 35mm slides give the smallest of the three types. Slides

smaller than the 35mm size are not practical for light show use. For projection distance information, see the projection chart on page 5.

As previously mentioned a quick changing slide projector is very important when showing photo transparencies. Half-recognizable images are used to their best advantage when they are flashed on and off the screen in a split second. Another valuable method is to project your slides on a spinning, mirrored ball. This puts you and your audience into the picture. For more details on mirrored effects, see Chapter 6.

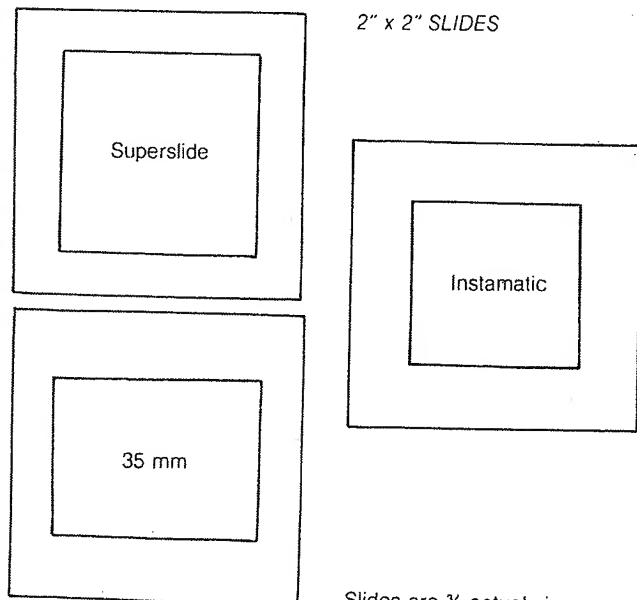
Image Montages

Remember the slides of the family on vacation? Don't discard them. Also save the slides that didn't turn out too well. Unwanted and imperfect slides can be the basis for very interesting slide montages. Purchase a box of superslide mounts. Then remount two or three slides on top of each other into one mount. The result . . . a double or triple exposure of useless slides made into one fascinating montage. Another way to do this is to mount fragments of several slides between sheets of clear plastic. The plastic holds the fragments in place.

35mm slides of moiré patterns or moiré pattern negatives cut to super slide dimensions can also give unusual effects. Placed in slide mounts with slide montages or plastic filters, these provide stark linear backgrounds which are excellent for surrealistic slide shows.

Color Montages

Color montages can be made by cutting and mounting color filters. Cut the color filter material into various shapes such as object outlines, letters, and the like. Sandwich these between clear acetate and insert them into a slide mount. When you project the slide, the color shapes will stand out on a clear background. Or, sandwich the color shapes between one square of clear acetate and one square of colored filter material. Mount and project this and you will get cut out shapes of certain colors on a surrounding, color background.



Slides are $\frac{3}{4}$ actual size

POLARIZED LIGHT

Light coming from a lamp vibrates in all directions. A reflector placed behind it gives light direction (beam), but it still vibrates at right angles to the direction of the beam. A piece of polarizing material (polarizer) in the path of the beam acts like Venetian blind slots, causing the light to vibrate in only one direction. In the light-beam, place a second piece of polarizing material (analyzer) with its axis (Venetian blind slots) at right angles to the polarizer. Very little light is transmitted. Turning the polarizer or analyzer transmits more or less light...the principle behind variable density filters.

Polarizing Effects with 35mm Projectors

You can use the phenomenon of light polarization to change colors on your screen without changing slides. To do this, you'll need certain materials. One you will need is birefringent material. Birefringent material is anything that's transparent and that takes on color when placed between polarizing filters. Cellophane tape and cellophane are commonly found examples of birefringent material.

To project 35mm polarizing slides, you must first make a polarizing spinner. This is done by mounting a polarizing disc on a motor and stand. This motorized polarizing spinner is placed in front of your projection lens.

Before making your polarizing slides, you should acquaint yourself with light polarization. Crumple a cellophane wrapper from a pack of cigarettes. Place it between two polarizing squares and hold it up to the light. You will see colors that weren't there before. Now, slowly turn one of the squares and watch these new-found colors change.

Cellophane Polarizing Slides

To make a cellophane polarizing slide, apply cellophane tape to a 2" x 2" polarizing filter square. Place the tape, layer over layer, criss cross, or crazy quilt. With its taped side facing front, place the slide in your projector. Turn on the motorized, polarizing spinner (which should be in front of your projection lens) and watch the colors change on your screen. Next, try folding a cellophane wrapper and taping it to a polarizing filter square. Place it in the projector as before, and project the colors. Note that the color is determined by (1) the number of layers of the birefringent material and (2) the angle of orientation of the material with respect to the polarizing filters.

Mylar Slides

After you've made a fair number of cellophane slides, try Mylar for a color change of pace. Mylar, a commonly-found transparent wrapping material, is available in several different thicknesses. Each thickness will project as a slightly different color shade ranging from deep colors to pastels. The thicker the Mylar, the lighter the color shade. For a starter, make a folded Mylar slide in the same way you made the cellophane slides. Using a spinning polarizing disc in front of your projection lens,

project this slide and compare the result with previous cellophane effects. After you have tried this, crinkle a sheet of Mylar without folding it. Tape the Mylar to a polarizing filter and project it. Note the shimmering, curtain effect. A single layer of thin Mylar will probably give you a deep purple with streaks of golden amber running along the folds. This will sometimes change to just gold.

Now try heating the Mylar. Hold a match beneath it just long enough to make it wrinkle slightly. Project it and the screen image will seem almost liquid with overpowering colors.

Mylar-Polyethylene Slides

Mylar-polyethylene slides are slides made with stretched polyethylene, Mylar, acetate, and a 2" x 2" polarizing filter. These slides use the stress patterns of the stretched polyethylene to create interesting lines, shapes, and color.

Cut a 2" x 2" piece from a polyethylene sandwich bag or shirt wrapper. Now stretch it as far as possible without tearing. Place it on a 2" x 2" polarizing filter. Place a 2" x 2" piece of Mylar on top of the polyethylene. Then, place a 2" x 2" piece of acetate on top of the Mylar. Tape all this material to the filter with cellophane tape.

Put this slide, with the acetate side facing the projector front, into your projector. As with the other polarized projections, a spinning polarizing disc must be in front of the projection lens. The screen is alive with changing color and various interesting shapes that sometimes also seem to change.

Crystal Slides

Crystal slides give, perhaps, the most intricate and fascinating polarizing effects. They're also the most difficult to prepare.

The preparation of crystal slides usually involves the purchase of slide cover glasses (the thinnest available), slide binding tape, and some crystallizing birefringent material such as resorcinol, sodium thiosulfate, menthol, or plain aspirin. Of these materials, resorcinol is the easiest to work with because it crystallizes quicker and thinner than the others. However, resorcinol can cause a serious skin rash, so be careful. Wear rubber gloves with this and any other material. Whatever the material you decide to use, always read its container label for caution notices and directions for handling.

There are various techniques for making crystal slides. And the best technique used by one crystal slide craftsman may not be best for another. The one technique used at Edmund Scientific Co. involves the following 12-step process:

1. Put on a pair of thin, strong, rubber gloves.
2. Heat a 2" x 2" slide cover glass on a hot plate.
3. Spoon a small amount of resorcinol, aspirin, or whatever you wish to crystallize onto the heated cover glass. Wait for it to melt. Some experimentation may be necessary to determine the temperature necessary to melt the material.

4. When the powder has become a liquid, place a second cover glass on top of the heated cover glass and liquid.

5. With a pair of pliers, align the cover glasses so that they fit exactly over one another. Do this while they are still on the hot plate.

6. Using the pliers, move this sandwich of glass and liquid to the edge of the hot plate. This can be accomplished by pushing or sweeping the slide sandwich along with the plier tips.

7. Grip the edges of the slide with the pliers and take it off the hot plate. Don't set it down!

8. With another pair of pliers, grip the slide at the edge opposite the one already being held.

9. Then, pass the slide from one pair of pliers to the other, each time gripping different edges. Keep doing this until the liquid between the cover glass sheets is completely crystallized. Then set the slide down on your workbench or table.

10. Place a 2" x 2" piece of Mylar on a 2" x 2" polarizing filter square. Note: This step is optional. Mylar gives extra color to a crystal slide. However, Mylar is not a necessity; good, colorful, crystal slides can be made without it. But, Mylar can make these slides more interesting and it's a good idea to use it if you have it. Thick or thin Mylar can be used. The thick type gives better colors. A good method for picking the right thickness is to choose the type that changes from magenta through green and back to magenta when held over a piece of polarizing material and viewed through a second rotating piece.

11. Place the finished crystal slide on top of the Mylar. If Mylar was not used, just place the slide on top of the 2" x 2" polarizing filter. Note: If a projector is set up to show crystal slides only, a piece of polarizing material and Mylar can be permanently mounted in the projector.

12. The finished slide should consist of a layer of polarizing material, a piece of Mylar (optional), a sheet of glass, the crystallized substance, and a second sheet of glass.

Place the finished crystal slide in the projector. The glass side should face the front of the projector. A spinning polarizing disc must be in front of the projection lens if there is to be any color change. Note: At what speed should the motorized polarizing disc be spinning? The answer to this question is up to you.

The above technique for preparing crystal slides has given Edmund crystal craftsmen uniformly good results. But it is not the only good method. Some decorative enthusiasts like to seal 3 sides of the slide with tape. Then they melt the material to be crystallized and introduce it, using a dropper, into the space between the glass squares. Capillary action draws the liquid into the slide sandwich. When this method is used, it is necessary to heat all of the equipment used to a temperature above the crystallizing temperature of the material used. If any of these materials is at a lower temperature, the liquid will crystallize too soon; maybe even in the dropper or when first added to the slide.

You'll probably want to experiment with crystal slide making to develop your own technique.

ORGANICS—The Hand Painted Slides

In the Overhead Transparency portion of this book, you saw how you can paint slides right on an overhead projector. Unfortunately, the 35mm projector cannot show a slide being painted. But it does have a compensating advantage. It magnifies the screen image much more than an overhead projector can in the same projection area. This is important because the bigger magnification shows every small brush stroke on the slide.

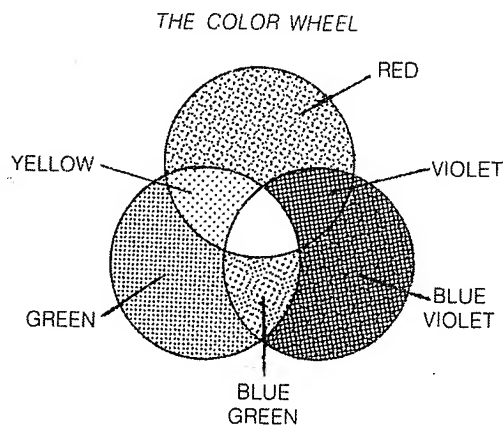
When painting organic slides, use transparent paints that project well. Our artists experimented with oils, acrylics, markers, projection markers, transparent drawing inks, water colors and, finally, transparent projection paint. This type of paint was one of the few that projected at all, and the only one that did not wash out, but remained strong and vibrant. You don't have to be handy with a paint brush to make excellent organics. Try these helpful techniques:

Flow Painting

Apply a drop of transparent paint to a 2" x 2" piece of glass or acetate. Then squirt thinner on the paint with a dropper or a syringe. Let the excess thinner run off the slide. Color will coat the slide wherever the thinner flowed; thick and deep in some spots, thin and light in others. Then add another drop of paint to another area of the slide and repeat the process. Try using a different color on the second drop. You can keep adding drops and paint to different slide areas for as many colors as you like. This makes for a multicolored, exciting slide.

Don't let complementary colors mix on the same slide. These colors are opposite one another on the color wheel shown in the illustration. For example, look at the positions of red and green on this color wheel. They are directly opposite and are complementary. When mixed, these colors will give you a mud brown. Colors located next to one another on the wheel are called "analogous." (For example, see yellow, green, blue.) These always mix well together and are good for multicolored organic slides.

Another method of flow painting is to apply drops of different colored paints to various areas of the glass or acetate. Then let thinner flow among them and run off the slide. This merges some of the colors and creates interesting flow patterns. Again, remember not to use complementary colors.



Sometimes you'll discover that your flow painted organics are not just right in a certain portion of the slide. You'd like to add color to that area but are worried that the additional thinner might run on the good areas of the slide and ruin them. The solution? It's easy! Just flip the slide over and flow paint the reverse side of the poor area.

Textured Organics

Texturing hand-painted and flow-painted slides will give the additional depth which makes a strong impact on the audience. This 3-dimensional effect can be done by dabbing the transparent paint while it's still wet. Use a porous object and dab and turn it on the wet paint. A cigarette filter gives good texturing effects. Tissue paper, sandpaper, or a dry brush also work well.

Some slides are textured with hair. This is done by laying the hair on the wet slide and lifting it off when the paint is almost dry. The hair can also be cut into small pieces and left right on the slide.

You can texture by scratching the dried paint with a razor blade or some other sharp instrument. You can probably think of a dozen other texturing methods. Try them all! Each could give you a slightly different texture and a vastly different image when projected.

Another interesting way of obtaining depth on the screen is to place 2 textured slides in the same slide mount. This projects an illusion of depth; one slide in the focal plane is clear and sharp, the other seems fuzzy and appears to be either in front of or behind the other slide. An interesting effect can be achieved by focusing the projector on the fuzzy slide and making the clear one fuzzy. This gives an effect of motion.

The Boiling Organic

The inside of a 35mm projector gets very hot when the bulb has been on for a while. It actually gets hot enough to boil certain liquids. You can put this to good use and have boiling organics in your slide show.

To prepare a boiling organic, you need two immiscible solvents with different boiling points but with approximately the same specific gravity. Dissolve a different dye in each solvent. Next, cut out a U-shaped cardboard or high-temperature plastic slide mask measuring 2" x 2" x about 1/4-3/8" thick. Place the slide mask on a 2" slide cover glass.

Place a second cover glass over the first and seal the bottom and side edges with tape. Squirt a few drops of each colored solvent between the glass. Then project! The slide remains stable for about 3 or 4 minutes and then the liquid with the lower boiling point begins to bubble. The colors will swell and burst on the screen. A wild, bubbling effect that never fails to fascinate the audience.

SPECIAL EFFECT DISCS

A special effect disc is a motorized disc that rotates inside the slide gate of an Edmund Visual Effects Projector (see Chapters 3 & 4). As far as we know, there is no other projector that can accommodate it. As the disc turns in-

side the projector, constantly changing images flow across the screen. The effect is something like an abstract motion picture.

There are 2 basic types of special effect discs. One consists of a single glass or plastic disc, usually about 9" in diameter. This disc has a center hole that accepts the shaft of the motor that spins it. This type is recommended for designs or random colors painted with transparent paints. As the disc spins, these designs and random colors move across the screen. It's also possible to tape on portions of photographic transparencies or moire patterns. However, the tape will be easily visible on the screen. This could be a desirable effect if cellophane tape is used and a polarizing disc is spinning in front of your projection lens. If the tape is outside the "gate" area, of course it will not project.

Another type of special effect disc eliminates this tape problem. This type consists of 2 glass or plastic discs. Transparencies, transparency fragments, moire patterns, or various shapes cut out of color filter material can then be sandwiched between the 2 discs. These discs can then be glued or taped around the edges. This portion should not show on the screen. Before sealing the sandwich, it's advisable to experiment with the projector and the special effect disc to determine what portions are projected. You can then position the elements of the slide and seal the edges according to the results of your experiments.

The Edmund Visual Effects Projector also accommodates a color wheel. The combination of a special effects and a color wheel can fill your screen with eerie, defocused, and seemingly-submerged images. (See "Color Wheels.")

OVERHEAD TRANSPARENCIES

An overhead projector can be an extremely valuable tool in a light show presentation, discotheque, theatrical production, advertising display, and the like. This section deals with techniques that you can use to create beautiful and attention-grabbing effects.

Squirt Painting

Squirt painting is an easy way to obtain unusual and sometimes startling effects on the screen. Start with a sheet of glass, acetate, or transparent plastic slightly larger than the stage of your overhead projector. Place this sheet over the stage. This protects the stage from the paint you'll use. Next, fill syringes or droppers with transparent paint. Be sure to use a separate container for each different color.

Begin painting by squirting the paint randomly but sparingly on the protective sheet. Watch the projection surface. It will appear that you're squirting-paint on the screen. This often has a startling effect on the audience. The movement and colors on the screen are fascinating.

If you move or tilt the sheet while you're squirt-painting, you can make the colors run together or in different directions. This is also an interesting effect.

A mixture of food coloring and water can be used in

place of the transparent paint. This mixture has the advantage of being easily removed from the protective sheet. However, it's more difficult to work with because it is often too watery and splashes or runs off the sheet. This can be useful if an emphasis is to be placed on movement rather than color. If you want a permanent record of your art, use the transparent paint.

Finger-Painted Transparencies

Finger painting, the art of kindergarten days, can be an adult art form on the overhead projector. A skilled, paint-tipped finger gliding across an overhead transparency can make a picture appear on the screen. Even if you aren't a Picasso, the novelty of projection painting will entertain your audience . . . whether they're light show spectators, children in school, or hospital patients.

The serious artist or hobbyist would probably not want to finger-paint or work fast enough for his art to serve as a light show attraction. But to a small select group of fellow artists and friends, he can use his brushes to paint on the transparency while his audience watches the screen. This eliminates the annoyance of people continually looking over his shoulder.

In both finger painting and brush painting, transparent paints should be used. If you'd rather draw than paint, or if you want a quick sketch for a light show, special drawing pens are available that use transparent, colored ink.

Polarized Slides on the Overhead Projector

Polarization can add changing color and movement to your overhead projection.

To make and use these transparencies, you need a polarizing filter disc, a motor, a mounting apparatus, several squares of polarizing filter material cut to the size of your overhead projector's stage, and some birefringent material.

The motorized polarizing spinner should be placed immediately under or in front of the lens. Make your polarized transparencies using techniques similar to those mentioned for 35mm polarized slides.

Moiré Patterns

Moiré patterns can be used to emphasize form in your slide show. Many discotheques use moiré patterns projected on go-go-girls and combos.

When projecting moiré patterns, move them and watch the unusual effects shown on the screen or entertainers. You can move the patterns by hand. If you can't be at the projector for the whole performance, work out a way of moving the patterns with a display motor. Use color moirés or add color filters to black and white moirés to add color to a projection. For another unusual effect with moirés, defocus the projector and watch as the forms seem to melt on the screen.

MULTI-IMAGE SHOWS

If you are using several slide projectors, you may want to have a more sophisticated animation technique. You can try drawing "cells" and shooting animation with your

camera or you can use puppets and move them a step at a time the way professional animators do. You might try "shooting" cars or people or clouds (or whatever) in motion and projecting the slides in sequence to arrive at an animated effect. There're many motorized devices on the market to help you time your shutter speed.

Slides can be made in many ways. Edmund sells a "Quick Slide" kit which allows you to "lift" pictures directly out of magazines and onto slides. They also sell special effects kits to help you form images with halos and rainbows and a horde of other kinds of graphic-arts-type photos. You might want to enhance your pictures with diffraction gratings. Over-exposure of a moving flashlight can give you a spectacular slide/light effect.

Think of all the kinds of animated effects you see in cartoons or advertisements on television. Most of them can be duplicated fairly successfully by a clever, patient amateur.

There are also slide mount kits available that allow you to mount slides into "stars" or circles or different quadrants of your screen. You can also buy "type on" slides to achieve titles or "announcements" which can be incorporated into your show.

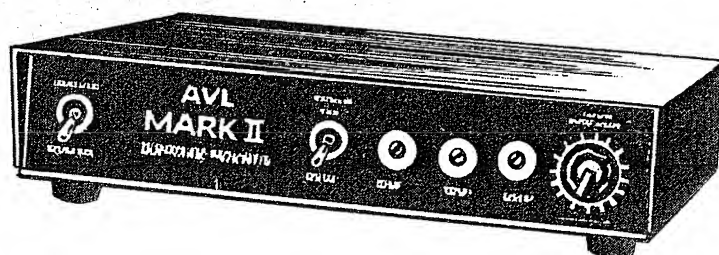
Thematic presentations of NASA slides or microphotography slides can make a marvelous part of your light show too.

Once you have your slides, what to do with them? More and more, multi-image is used as a part of an elaborate disco show or, conversely, special effects are used more and more with multi-media presentations.

You can manually key in your slides to tell a story that is enhanced by your light show. You can "do" some of your effects using slides as well as lighting. Some slide presentations are so animated, they're almost a light show in themselves.

There are many ways in which you may automate a slide presentation. In recent years, the A/V industry has burgeoned with hardware designed to give you versatile control over slide projectors. From simple 2-projector systems that allow you to dissolve or cut from one slide to another without having to go through a brief moment of black as the slide advances, to systems utilizing 15 projectors or more, the only limitation is your budget!

The state of the art is probably best represented by Audio Visual Laboratories (AVL) with their line of A/V hardware which goes from the Mark II Dissolve, which allows you to cut, alternate and dissolve between two projectors, to the spectacular Show Pro V computer programming system.



A "cut" switches the lamp of one projector off and the other lamp on. The projector which goes off moves ahead one slot of the tray so that a new slide is ready to come up on the next command. A "dissolve" fades one lamp on and the other lamp off.

An "alternate" can be used in several ways: it can either flash one lamp on and off without advancing the projector, or it can "alternately" flash each lamp of two projectors on and off so that, if your slides are showing action, you get an animated effect. The alternate can also be used to flash the lamp of one projector while the lamp of the other stays lit as is done on television when there's picture of a product and the price flashes on and off over the picture.

If you load your trays properly, write a script with the cues noted, you can then record the show onto magnetic tape in synchronization with a piece of music and play it back any time without having to manually "punch" your show.

A few years ago, a Mark II or the equivalent was all that was available. Inevitably, A/V people wanted more projectors focussed on more screens and the A/V programming industry started to grow.

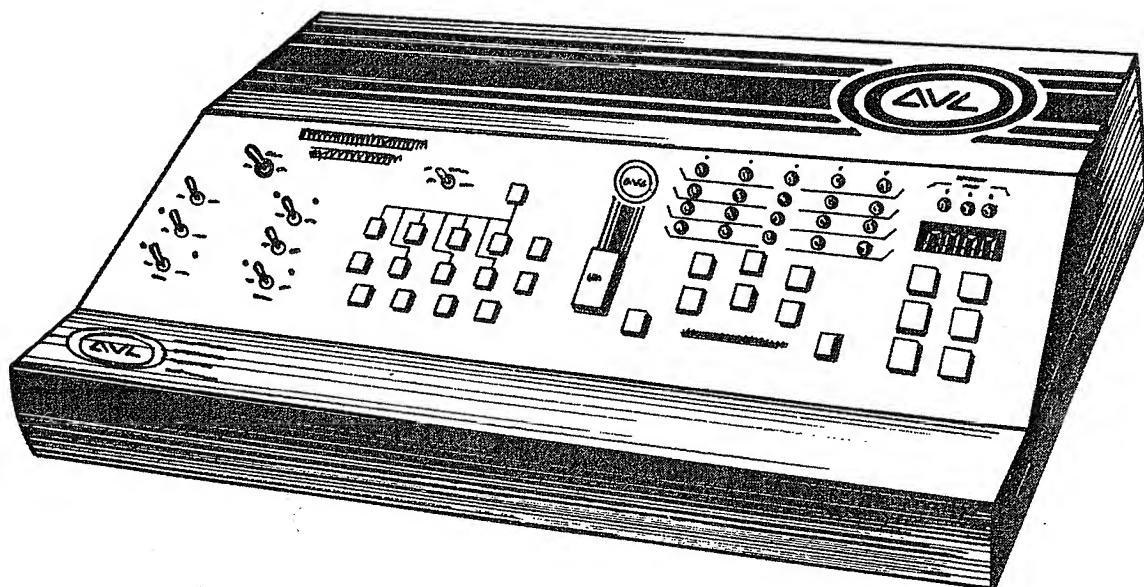
The most advanced piece of equipment available at this writing is the Show Pro V which is an actual micro-computer which controls 15 projectors at 10 cues a second for almost limitless effects on a screen. The Show Pro V has a memory which allows you to try effects out on the screen and edit them as you go along. Old dissolve systems needed to be told what to do at each step along

the way, but the Show Pro V (or the Show Pro III, its little brother which controls 6 projectors) remembers the sequence of actions you've told it to do so that you can back up to look at what you've tried before you record your show on tape. With these units you can even program auxiliary equipment such as special effects or 16mm projectors for total light show capability.

Between the two extremes of the Mark II and the show Pro V is a wide range of equipment. There's a punch tape programmer from AVL as well as many other manufacturers. A punch tape records cues on (generally) eight holes of mylar or paper tape and can be cued from a tape deck to control banks of projectors. There are smaller and larger dissolve systems with varying rates of dissolves from half a second to 48 seconds. There are computerized multipurpose programmers which can be used to program other dissolve units. There is almost no limit to what is available.

AVL even has a programmable dissolve unit which can either be programmed in real time for three projectors or used as a play back unit from the Show Pro V which allows you to program in "leisure" time because of its memory.

If you live near a large city, you may well have seen some of these pieces of equipment at work. Edmund Scientific uses the Show Pro V in their theatre to operate a slide/light/sound show. If your school has an A/V department, you might want to get involved with your equipment and theirs. It's a young field with lots of room for growth and new ideas.



Show Pro V 15-Projector Computer Programmer

ABOUT LAMPS AND LIGHT SOURCES

Any handbook on light shows or unique lighting is incomplete without a section on light sources. No matter whether you are planning a complex, large-scale light show or just want some "atmosphere" lighting for various rooms in your house, a knowledge of the different types of light sources could save you money and give you additional lighting ideas. This section deals with the various types of light sources and certain important facts including how each source works. We have divided the entire section into two main parts, light producers and light controllers. Light producers are defined as prime sources of illumination. Light controllers are defined as devices which may collect and direct the light from a prime source.

LIGHT PRODUCERS

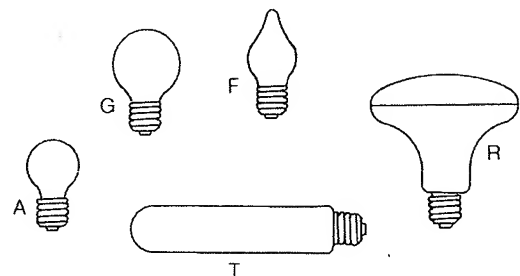
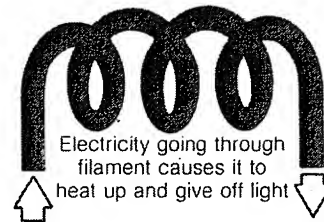
Let's start with a brief run down of light producers with an eye toward their utility, cost, service life, and some points of interest about their role in unique lighting.

The Sun

Any discussion of light producers properly starts with the sun. Most of us have seen signals transmitted by reflecting sunlight off a polished surface or mirror toward a distant receiver. This method, which we know as heliography, has been used by man for thousands of years. The speed of transmission, high intensity, and the collimated (parallel) form of the sun's rays are points in its favor. Further, the sunlight can be blocked out using opaque surfaces or directed using optical devices. Light from the sun can be reflected from flat mirrors, oscillating mirrors, mirrored spheres, foils, and many other surfaces to achieve an appealing optical display. However, when we need a light producer on a cloudy day, after sunset, or in an area not accessible to sunlight, we must supply our own.

Incandescent Filament Lamps

The most commonly manufactured light producer is the incandescent filament lamp. Here, an electric current is passed through a thin wire in a glass envelope from which most of the air has been removed. These lamps are made in various shapes, wattages, base shapes, filament designs, as well as with clear or coated envelopes. Should you plan on using a sharp incandes-



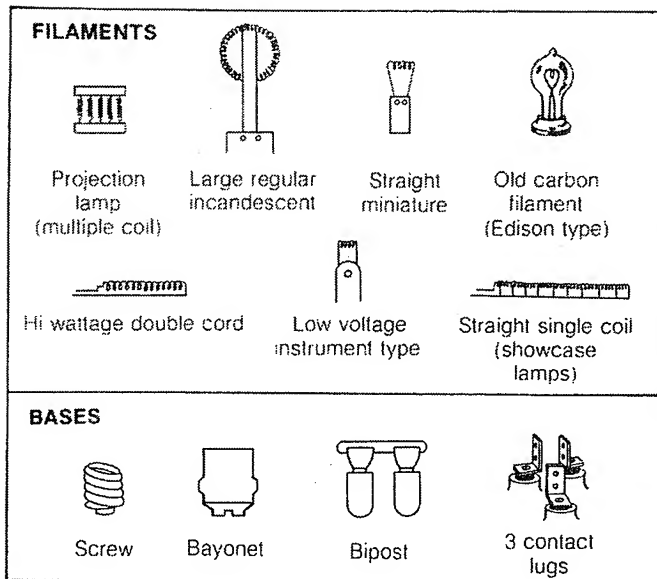
Letters refer to industry type

cent filament spotlight in your light show, it should have high wattage, a clear envelope, compact filament arrangement, and a base that fits the socket in the spotlight housing. This type is generally called a projection lamp.

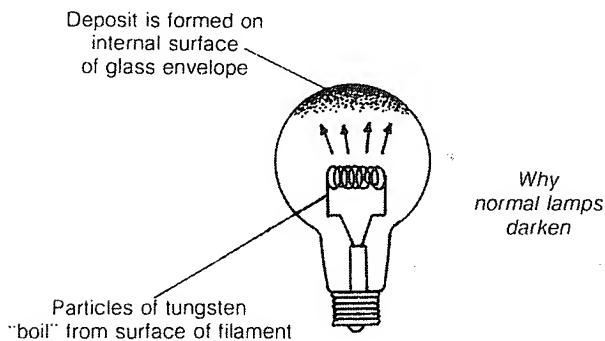
If you want a diffuse light beam (softer, with a less well defined circular pattern), use a lamp that's coated or frosted. An alternate method would be to place a diffusing glass plate in front of the lens of the spotlight.

Generally speaking, an incandescent filament lamp can be selected in a wide range of wattages from less than 10 to as much as 1500. Some are manufactured with thermostatic (heat controlled switch) blinkers such as Christmas tree lights. Other factors which appeal to the hobbyist and amateur light show operator are the absence of a warm-up period often necessary with more elaborate and expensive lamps and the ease of dimming by means of simple devices.

Looking at the other side of the coin, we are limited by the clumsy size and excessive heat produced by the higher wattage incandescent filament (such as is used in projectors) requiring cooling fans to be incorporated into the designs of such lights. This necessity obviously runs up the cost.

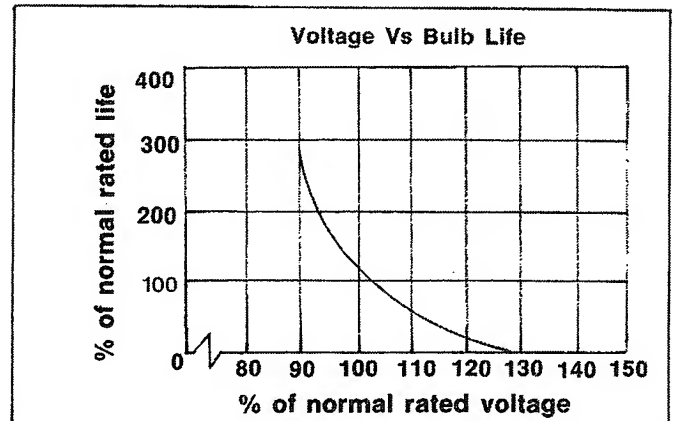


In its infancy, the incandescent lamp used a large "straight" filament within a vacuum. This resulted in a short lamp life because of filament deterioration. Gradually, manufacturers changed to coiled filaments in an atmosphere of inert gas (argon, xenon, or krypton) and nitrogen. Some time after this type of lamp had been put into service, its envelope slowly blackened. We have all seen this happen.



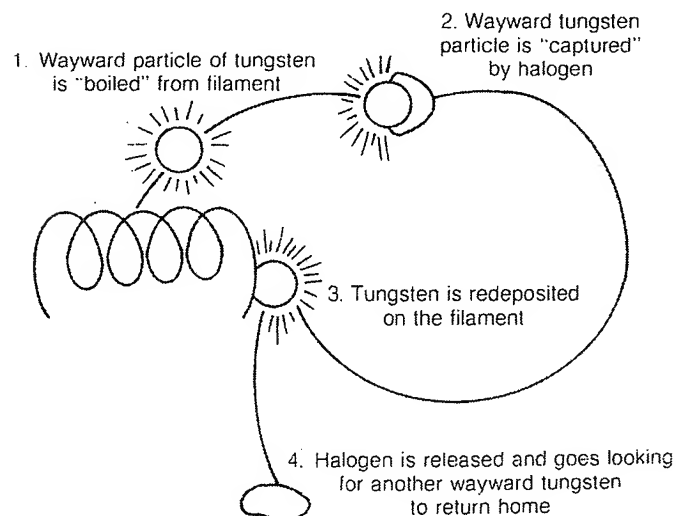
This black deposit is actually fine particles of tungsten which, because of the heat of incandescence, have evaporated from the filament. We can liken this to a pot of water being heated with a plate held above it. As the water evaporates it is deposited on the relatively cool plate (condensation). As the envelope blackens more and more, the lamp gives off less and less light, finally failing when the filament breaks.

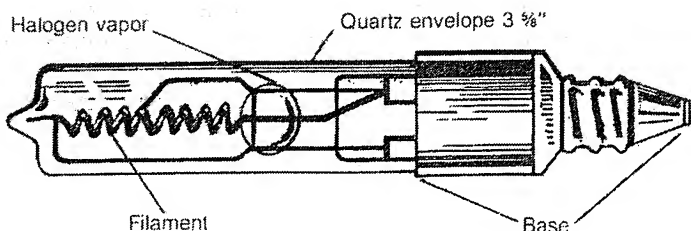
Lamp manufacturers give voltage ratings and lamp lifetimes corresponding to these ratings. For example (referring to the chart), if you operate a lamp at 90% of the manufacturer's suggested voltage, you may increase the operational life of the lamp to 400% of its rated value. On the other hand, if you operate the lamp at 125% of the manufacturer's suggested voltage, you decrease the operational life of the lamp to 30% of its rated value.



Halogen Lamps

The quartz-halogen lamp is constructed to solve the blackening problem. It too has a tungsten filament, but its envelope is heat resistant quartz, and in the place of the inert gases, we find a halogen (usually iodine or bromine). Chemical reaction between the tungsten and the halogen causes any deposits of tungsten from the filament to be removed from the envelope and returned to the filament, thus prolonging the life of many of these lamps to better than 2,000 hours.





The intensity of the quartz-halogen lamp is much greater than a comparably sized incandescent filament lamp, but we have to pay for the advantages by accepting much higher bulb temperatures. The halogen lamp is used best in spotlights, floodlights, and auto driving lights where high intensity, high illumination, white light quality, and long service life are desirable.

Fluorescent Lamps

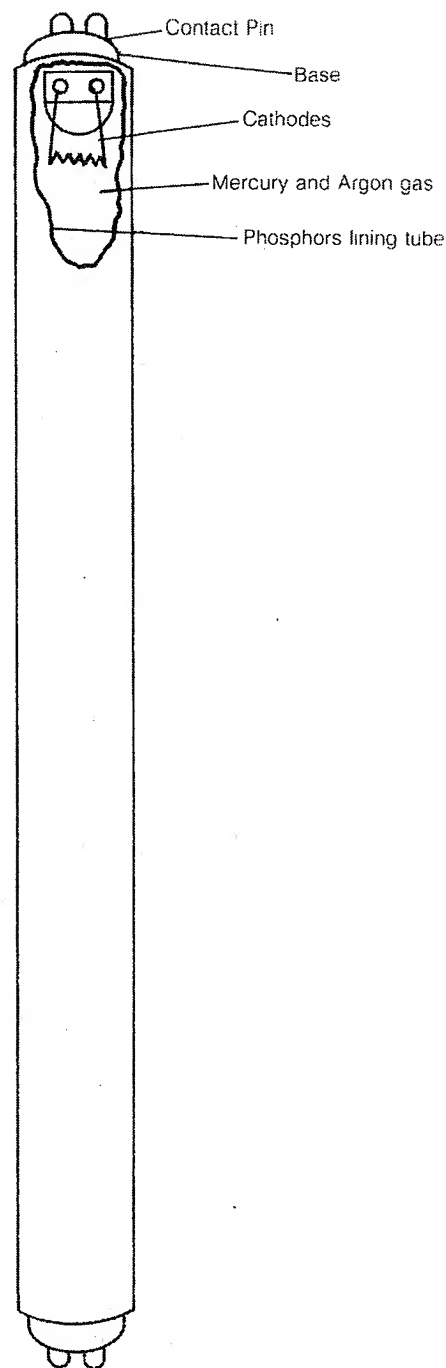
The fluorescent lamp consists primarily of three parts: 1) a tube coated on the inside with phosphors; 2) at the end of the tube there are caps containing electrodes; 3) within the tube, there exists low pressure mercury gas, and a small amount of argon gas.

When proper voltage is applied across the electrodes, an arc is established with the help of the argon. This arc, or discharge, going through the mercury vapor gives rise to ultraviolet radiation ("black light") as well as a small amount of visible light. This arcing process requires heavy and fairly costly ballast units or transformers to control currents. Now when this ultraviolet radiation strikes the phosphors or the wall of the tube, a large quantity of visible light is emitted.

Consider some of the advantages of fluorescent light. These tubes are available in either hot cathode (preheat starting) or cold cathode (instant starting) types. They may be purchased in either straight or circular tubes at moderate prices. It is also known that you get better efficiency as the tube increases in wattage. Color versatility is provided by the use of slip-on type plastic color filters. However, there are also disadvantages associated with the fluorescent lamp. You can't control (focus and collect) light from a fluorescent lamp, since the light producing area is so large. Therefore, you can't really take advantage of its white light potential in theatrical applications. An exception is its use as an area illuminator.

While we're on the subject of disadvantages, let's not forget the interference with AM radio band frequencies caused by the mercury arc. This can be eliminated, however, either by repositioning the radio aerial farther away from the fluorescent unit, by installation of interference shields, or by using power line filters for the lamp.

If you have anything rotating or oscillating at some small multiple of 60 cycles per second (this is 60, 120, 180, etc. cycles per second), you may find yourself watching it slow down, blur, or stop altogether due to the stroboscopic qualities of the fluorescent lamp.



Carbon Arc Lamps

The low-intensity carbon arc lamp is started by passing a current across two carbon electrodes which are barely touching. As these electrodes are separated slightly, an electric discharge occurs between them. It takes perhaps 50 volts to accomplish this. The tips then start to glow and reach temperatures as high as 7,000° F. This heat is so intense that the air separating the tips breaks down into charged particles (these are positive and negative) forming a so-called thermal plasma. This plasma can reach temperatures of greater than 30,000° F. The light given off by the arc itself is yellow-violet in color, as opposed to the white hot light given off by the tip (especially at the positive tip or anode if a DC voltage is used). Actually, the major portion of the usable light comes from the glowing tip. There is a wearing away of the electrodes and provision must be made to feed them in continuously, keeping the separation constant.

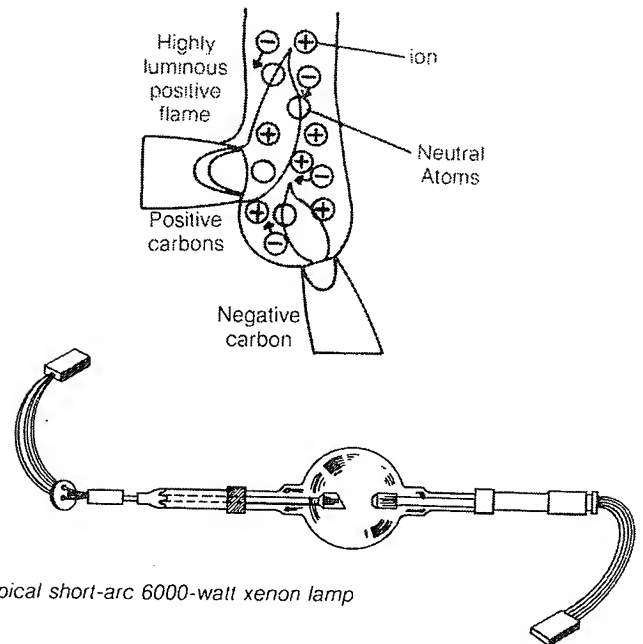
In order to develop a high intensity arc, the cores of the electrodes are made larger and filled with great quantities of flame materials. As the voltage is applied, this flame material is rapidly used up. At the same time, the flame material envelops the area around the tips, creating a crater at the anode which glows brilliantly. High intensity carbon arc sources are used in motion-picture film projectors, searchlights for the military, and other heavy duty applications. They are a source of white light similar to sunlight, with ten times the illumination of a low intensity arc. They are used to throw a beam across large arenas. However, they are bulky and expensive and require water cooling at high powers and external venting in many cases.

Short Arcs

The short arc lamp is characterized by its close approximation to a point source, where a high pressure discharge occurs in a very limited area. In the case of mercury-xenon and mercury lamps, some argon is introduced along with the mercury-xenon or mercury into a quartz bulb with fixed electrodes at either end. The addition of the argon cuts the warm up time in half. The mercury arc provides a controllable black-light source (the fluorescents also provide ultraviolet but are not controllable because of the extensive illuminating area). The xenon short arc operates just about the same, giving a light yield similar to daylight. It should again be noted that water cooling is required at greater than 10,000 watts.

An example of a direct current arc lamp is the zirconium concentrated arc type. The glass envelope is filled with argon, and the cathode (negative electrode) is a zirconium oxide filled tantalum tube. The source is almost a pin-point and yields some light in the visible range as well as some in the ultraviolet and infrared ranges. This type of source requires special power supplies and ballasting, usually costly. Short arc light sources are utilized mainly in spotlights and projectors, due to their high illuminance, low maintenance, and clean operation (as opposed to the carbon arc, whose operation generally is somewhat smoky). Since the electrodes of a short arc lamp are fixed at a constant separation, they cannot be moved together to "strike" the arc. They must be started

by either a high voltage pulse or by applying an ionization voltage to a third electrode incorporated into the lamp itself.

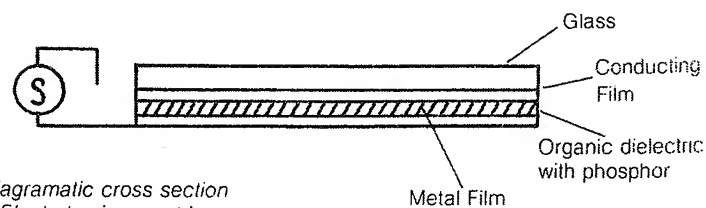


Typical short-arc 6000-watt xenon lamp

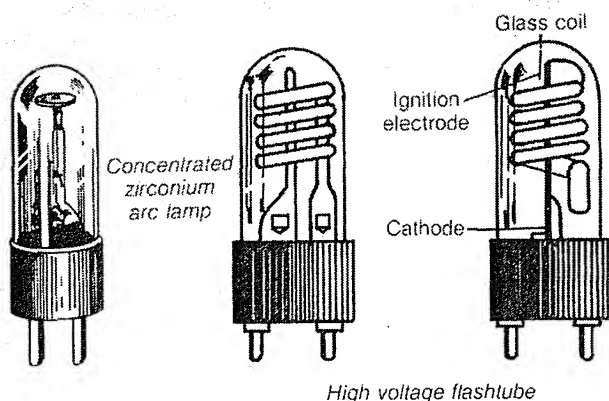
Electroluminescence

Under the proper conditions AC voltage fluctuations will directly excite phosphors, causing them to emit light. If you connect an AC source across the sandwich (capacitor) shown, you can produce colored light of your choice. The color depends on the type of electroluminescent phosphors that have been coated onto the glass or ceramic layer. For example, phosphors of magnesium arsenate and tin will yield a deep red, while hexagonal zinc sulfide and copper will give a green light. Refer to the segment on fluorescent lamps and you will see that an additional step of creating a mercury gas discharge to excite the phosphors was necessary.

Electroluminescence is essentially a low illumination source. This means that it provides enough light for us to see it, but it does not provide enough light so that we might see another object in the area. Due to its availability in plastic form and its low illumination level, it is presently used in clock faces, telephone dials, indicator applications, indoor signs, decorative lighting, and night lights. It can be used for ornaments on clothes or for the clothes themselves.



Diagrammatic cross section of Electroluminescent lamp



Strobes

Three kinds of stroboscopic light sources are covered in Chapter 10. The operation, applications, and limitations of the mechanical and fluorescent strobes are amply covered there.

The heart of the electronic strobe is the high voltage flash tube. This is a xenon filled Helix (spiral) or U-tube with electrodes enclosed within a glass envelope. A power supply, basically, is a source of electrical energy which charges a capacitor. A trigger circuit energizes a third external triggering electrode that is wrapped around the xenon tube. The high voltage applied to this trigger electrode ionizes the gas within the tube and "prepares the path" for the main energy stored in the capacitor to discharge through the tube. Sometimes as much as 10,000 volts pushes perhaps 100 amperes through the xenon, causing it to glow brilliantly for a fraction of a second (flash).

The trigger can be timed, or synchronized, with a rotating machine, as is done in automotive ignition timing using the No. 1 spark plug wire. It is also possible to use a multi-vibrator or relaxation oscillator (an electronic device for producing a periodic or repetitive signal like a metronome) for triggering. In the case of theatrical or unique lighting, this would be the suggested method.

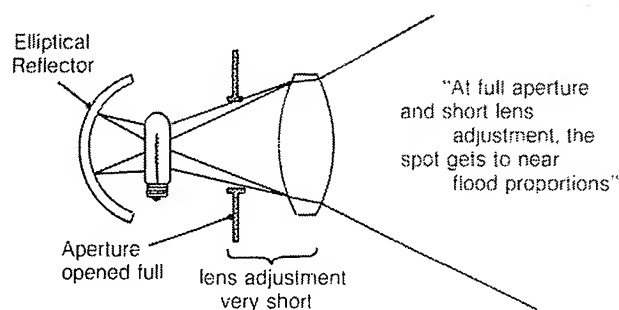
LIGHT CONTROLLERS

The Importance of Filament Size and Image Control

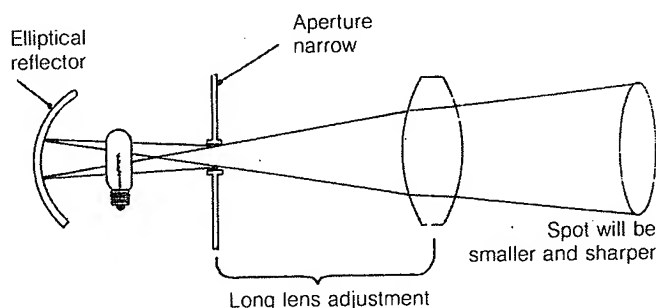
We are going to discuss the effects of filament size on types of images in some common lighting devices you may require for your light show. To understand the importance of filament size, consider the filament as a point source (the usual ideal case in text books). The image is quite sharply defined. But whoever saw a lamp with a point filament? A more realistic situation would be the extended source (many point sources). In this case a vertically extended source produces an image which is horizontally sharp, but vertically diffuse and containing an enlarged image of the filament. If you want to operate the lamp in a horizontal position, the image produced would then be horizontally diffuse and vertically sharp.

We know, however, that the smaller the filament, the less the allowable voltage. Intensity is highly dependent upon voltage. Thus, a small filament, low voltage lamp can produce only a limited amount of illumination. A larger filament lamp carrying larger voltage (necessary

for the required illumination) will cause an unsatisfactory diffuse display including an enlarged picture of the filament itself.



Further, small voltage lamps can't be operated on 110 V AC without using a bulky and costly transformer. How then can we handle this technical dilemma of achieving a bright, sharp display that's free of filament image? Optical arrangements of reflectors and lenses offer a practical solution.



One way is to start with an extended incandescent light filament as in an ellipsoidal reflector spotlight, for example. Essentially, the light rays are bounced off the elliptical reflector back through the lamp, through an adjustable aperture, a projection lens, and then to a screen or target. This can be varied from a soft, broad pattern down to a fairly sharply defined bright pattern by using the aperture control and focusing the projection lens. At full aperture and short lens adjustment, the spot gets to near flood proportions.

A projector operates differently than a spotlight to overcome the basic extended filament problem. Light from an extended source is reflected through the lamp into a condensing lens unit and then through a projection lens to the screen.

In the event that you wished to use a projector to show slides, the transparencies would be placed at the position indicated in the drawing on page 1. Should you need to throw the beam a greater distance to a screen or target and yet keep the same size image, the projection lens must be moved out toward the target and its focal length increased. Also, the focal length of the condenser lens would have to be increased accordingly so as to image the filament coils on the projection lens.

Color Control

In order to get the most dramatic chromatic effect for the money invested, the unique lighting enthusiast should acquaint himself with the applications and limitations of materials presently available.

Color sources come in the form of painted or dyed lamps, colored glass lamps, dichroic lamps and external filters, to be used with white and sometimes colored sources. The most common of the painted or dyed group is the incandescent filament Christmas tree lamp. It is a low wattage, relatively low illumination lamp with a frosted color application. It is available in a broad range of colors, and in both standard and self-flashing types at small expense.

It should be emphasized that we're not restricted to just the commercially painted or dyed lamps. We are now able to buy paints or dyes and can create any color or combination of colors desired. These may be applied to a variety of bulb shapes and sizes. Lamps with tinted clear glass are also desirable when you wish more illumination than painting or dyeing will allow. However, your choices of shapes, sizes, and colors are limited.

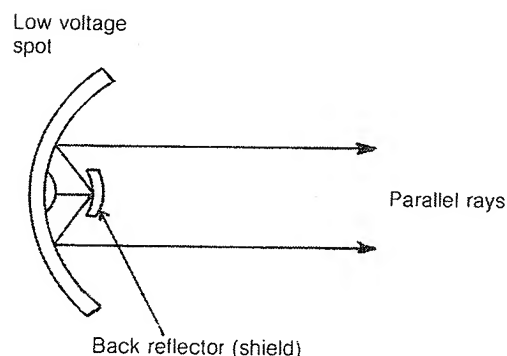
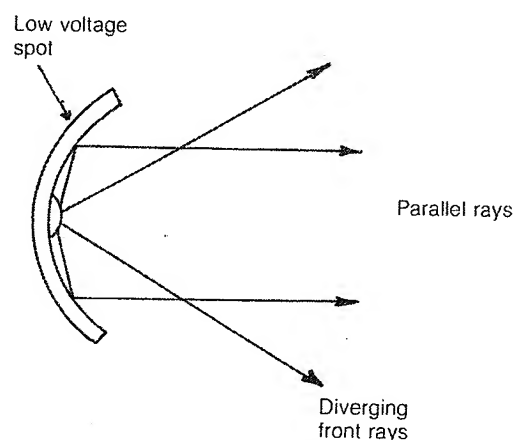
Another way of getting more flexibility and novel results is by the use of filters. These come in glass or plastic and may be the slip-over type for fluorescents, or the flat type for use with standard lamps or projectors. Filters are not true optical surfaces and will not pass all the light that enters them. Therefore, we have to exercise some judgment on the selection of a primary illumination source.

The dichroic lamp, usually a 150-watt unit, yields greater color purity at moderate expense than most other color lamps. Presently, however, the range of color is limited. The dichroic lamp operates on the optical principle of interference using an internal coating of the lens of the lamp. It doesn't cost that much more to go first class, and the effect of these lamps is well worth the additional expense. A general comment regarding the use of colored lamps would be in order now. If you want to cast shadows with a lamp, a frosted lamp will give rise to a diffuse image, while a clear colored lamp with a small filament will give you a well defined sharp image. For your convenience, we have included a color source comparison chart.

	Duration of Color		Range of Purity Color		Gross Cost	Choice of Shape, Wattage, Voltage
Dichroic	Best	Best	Fair	Fair	Highest	Fair
Tinted	Good	Med	Fair	Fair	Med. Hi.	Fair
Painted	Med.	Fair	Med.	Med.	Med.	Med.
Hand Painted	Med.	Fair	Best	Best	Best	Most Limited
Filter	Fair	Med.	Med.	Med. Hi.	Med. Hi.	Best

Low Voltage Versus High Voltage Spotlights (Sealed Beam)

The name spotlight on a lamp can sometimes be misleading. Therefore, let's take an example which may help us make the point. Consider the average 110 volt AC spotlight lamp (a very common item). Notice that this lamp has a large filament and a diffusing lens. This means that it tends more to act as a floodlight than a spotlight. On the other hand, the small filament and the clear lens of a low voltage DC automotive spotlight tends to produce a smaller, more sharply defined circle of light. An important refinement of this spotlight is the inclusion of a back reflector or shield (see Illustration) which eliminates widely diverging front rays and just leaves the parallel rays, reflected from the reflector. However, in order to use the better type spotlight, you must use a power supply which converts 110 AC into 6-12 volt DC.



ATTENTION GETTERS

Heat Driven Drum Type Lamps

A rotating multi-colored light is an inexpensive way of adding color dynamics to a room, stage, or bandstand otherwise lacking this quality. Here's how a typical unit works. Multiple lenses in the form of a sphere are mounted in a large golden colored star. Within this sphere an incandescent filament lamp shines through a transparent star decorated drum and fan combination which rotates through a full circle powered by rising hot air currents. The resulting filament images can be shown off to best advantage on a curved surface screen or by placing the lamp in a corner.

Beacon

We can also use a four color (red, orange, blue, green) full circle rotating Fresnel lens beacon for a novel and attention getting light display. These are usually motor driven rather than heat actuated.

Color Console

A battery of four, colored, sealed-beam lights (red, green, amber, blue) can be combined with a transformer as a portable package. The lamps may be operated in either a steady or blinking manner, and either singly or in combination. The advantages to the operator of the light show of the above three items are: (1) they are portable; (2) they are relatively inexpensive; (3) once set up, they require no operator; (4) they supply vivid color to any room with minimal effort.

THEATRICAL ILLUMINATION

Theatrical lighting used in legitimate productions should serve as valuable background for those of us interested in unique lighting. For example, the seating area requires low-level, dimmer controlled, diffuse lighting as well as shielded aisle lighting to assist seating in the dark. There are, of course, safety lighting of fire exits and lighting provisions for maintenance and cleaning. The stage, in whatever form it may be (rectangular, round, shell, arena, platform or bandstand), requires an array of specialized lighting units which you may wish to use in part of your light show.

Stage lights can be divided into two groups, area illumination and accent types. Unique lighting devices can stand as a third group or be used to augment existing standard lighting. Area lighting on a stage requires floodlights in a number of locations. Usually there is a large backdrop (cyclorama cloth) covering the entire rear and some of the side areas of the stage. The cyclorama cloth can be illuminated from both its top (border) and its bottom

(foot) for its entire length. First and second borders hang vertically from the ceiling extending the full width of the stage. Their purpose is to frame in the top of the stage for the audience regardless of how close or how far back one sits. Now, behind many of the borders there is a row of tiltable lights.

Footlights are at the front part of the stage, extending most of the width and either partially or wholly concealed from the audience in a trough. In addition to these, there are adjustable pendant lights on the side of the stage as well as portable flood and spot units. More flexibility is available by using connecting outlets placed around the perimeter of the stage.

Accent lights are ellipsoidal reflector spotlights, Fresnel spotlights, pinspots, projectors and various other specialty spotlights. These lights are positioned behind the first border, at the side of the stage, inside both corners of the stage (tormentors and teasers) on the front face of the balcony, along catwalks in the ceiling, and in vertical arrangements on the sidewalks, shielded to the rear. Also we realize that the first border is predominant in the amount and types of light that are carried. In the full commercial stage, there is a dimmer control for all fixed lights, either singly or in combination, and in some cases, there is remote control from locations other than backstage.

YOU'RE THE LIGHTSMITH

In presenting your particular show, you may choose to use only a part of the various types of standard lights available in combination with the recently developed unique lighting techniques. This, of course, is an individual decision.

A couple of incidentals are in order at this point. For example, which type is the sharpest and which is the most diffuse? The Fresnel spotlight is the most diffuse with the plano-convex spot somewhat sharper. At the other extreme is the ellipsoidal spotlight, follow spotlight, projector, and finally the sharpest of all, the pinspot. Given a good sharp ellipsoidal spot, a rotatable perforated disc, and a focusing lens, you have in effect, a pinspot. If you have one of the new 35mm small projectors, a bracket can change it quickly into a tiltable projector spot and a disc will convert it to a pinspot.

We have presented some of the basic technical background on light sources. Use this as starting point. It's up to you to apply this information to your own unique lighting requirements. Experimentation and creative design must be added to bring off a successful, unusual, and entertaining light show.

ABOUT ELECTRICITY

The original light show was provided by the rising and setting sun. The first man-made display probably involved fire in some form, but the present day variety are almost all run by electricity.

A small light box and other minor display pieces pose no problem electrically, but the bigger and fancier shows consume a lot of power. If the wiring in the building where the show is held can't stand the gaff, the light show may do more than just make pretty lights . . . the display could include burning down the building. You should know just a little about electrical circuits.

MEASURING ELECTRICITY

The first thing you need to know about electricity for exotic lighting is something about how to measure it. Electricity is measured in volts and amps. Power is measured in watts. Voltage is the force pushing the current through the wires. Amperage is the volume or amount of current passing through a circuit at any instant. Nearly all electrical devices (the only exceptions are home-built units) give their wattage on the nameplate. Watts are units to measure the rate at which power is consumed. The basic way you use this information is in the formula: $\text{Watts} = \text{Volts} \times \text{Amps}$

You can turn it around to get:

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts}}$$

For example: Suppose you have a 500-watt projector designed to operate on 115 volts. Will a 10-amp fuse blow if you plug it into the circuit?

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts}}$$

$$\text{Amps} = \frac{500}{115}$$

$$\text{Amps} = 4.35$$

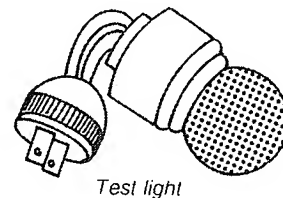
The projector will draw about 4-1/3 amps so you can use two of them on the circuit without either blowing the fuse or overloading the wiring. However, three such projectors would almost certainly blow the fuse.

CIRCUITS

The more elaborate A/V programming devices need to draw power from one circuit for the programmer, the power packs and the tape deck so that all the units are in phase with one another. How do you identify the cir-

cuits you have to work with? Do you merely count the number of outlets in the walls of the room where you plan to have your light show? Hardly. It may take a little testing, but it's not really difficult to find out what outlet is fed by which circuit. In almost any electrical store, you can buy an inexpensive test light.

You could also make one from a light bulb socket with a regular 115-volt plug as part of it. Or, you could even use a small lamp. The technique is to take the testing de-



vice and plug it into a socket. It should light. Then, find the fuse box or main circuit breaker panel for the house, room, auditorium, or apartment and turn the various available circuits off and on, one at a time, until the test light goes out. Leave all the other fuses in place or the circuit breaker turned on. By plugging your test light into first one outlet and then another, you can find all the outlets which do not work. These are all controlled by the single fuse or circuit breaker that is disconnected. They are all on the same circuit.

Make a rough sketch map of the area of your light show or display and indicate the outlets in each room. Then, by numbering each outlet to correspond with its circuit, you can tell how many circuits you have to work with. In an apartment, it will usually be only two or perhaps three. The larger apartments, or those in modern buildings, may have more. Most newer homes will also have more. . . perhaps seven to ten circuits if recently wired. Business buildings will undoubtedly have more and larger capacity circuits.

While you are checking the circuits, it's wise to note the kinds of fuses required. If more are not on hand, lay in a small supply of the correct amperages. You may need them, and there is nothing darker than a fuseless light show. Circuit breakers can simply be flipped back to the "on" position once the overload has been removed from the circuit.

PERMANENT VS TEMPORARY LIGHT SHOW WIRING

Your next problem depends on the nature of the light show. Is it something permanent? Or will it be temporary? The whole way you go about powering these two types of shows is different. A permanent show, such as a room decorated with light walls and a light ceiling, requires permanent wiring to run it safely and conveniently. A temporary display can be adequately handled by temporary wiring if it is planned and set up properly.

For a permanent show, figure out not only the number of amperes required to meet the lights you plan for now, but also add in extra capacity to meet surge requirements and for anything you might conceivably think of using in your show in the future. Then, figure in some extra capacity as a fudge factor.

Electrical surge must come into your current planning when you are working out limits. Surge is the added current that is needed to get an electrical device started, especially an electric motor. Even light bulbs draw more current during the instant when they are first turned on. It's needed to heat up the filaments. Projectors have quite healthy motors in them to run the cooling fans. When you first turn on a projector it will take considerably more current than it will once it's running. Current surge is the reason why your house lights may dim slightly or your television picture "shrinks" when the furnace or refrigerator first comes on. You can design your circuits with enough reserve to handle surge demands, or you can use slow-blow fuses. These are fuses that withstand an overload for a short period before blowing. Either way, current capacity to meet surge requirements is a must in the electrical planning.

Suppose you consider 500, 7-watt Christmas tree bulbs for a light wall, three 500-watt projectors, a 1,000-watt projector, and some other odds and ends for a big, permanent display. This will call for 500×7 or 3,500 watts for the light wall plus another 2,500 watts for the projectors. . . a total of 6,000 watts. 6,000 watts at 115 volts works out to 52.2 amps.

For 52 amps, you might think that three 20-amp or four 15-amps circuits would be sufficient. This is a case of good theory but poor practice. Anyone who plans a show of this magnitude is the kind of guy who will, inevitably, add to it. Putting in the wiring for 10,000 watts will cost very little more than that for 6,000. Whether you have to hire out the job or can do it yourself, you will have the electrical capacity ready to meet any future needs.

If you run a business where you may want to stage a series of light shows. . . perhaps a discotheque. . . it will definitely pay to install adequate wiring in the first place. It may well be required by laws of your community. Not complying with your local building code could endanger your insurance coverage in case of fire.

If you own a house, you might consider installing the wiring yourself. If you do, remember it will have to meet

the local building codes and be inspected by your town's building inspectors. There are many texts and how-to-do-it books available on home electrical wiring.

For a permanent show, just make sure you have adequate electrical power and if you do not have it, install it.

For a temporary show, you run into different solutions for the same electrical problems as a permanent show, but you don't have to be quite so neat about solving them. The laws of electricity, like all natural and scientific laws, must be obeyed or you face the consequences. In the case of electricity, practically speaking, this means that overstepping the lines costs a blown fuse at the least, and, perhaps, a serious fire at the worst. One advantage of a temporary show is that it is apt to be less elaborate than a permanent show that has had a chance to grow. Therefore, it will probably require less power.

For example, you may have the same three 500-watt projectors and perhaps two 50-blinker lightboxes. This works out to the same 1,000 watts for the projectors and 700 watts for the light boxes. The blinkers mean that all the bulbs will not be lit at the same time in the boxes, so call them 500 watts together. (However, when light boxes are warming up, all the lamps are lit until they start blinking.) This is 2,000 watts or 17.4 amps at 115 volts. You'd be loading a 20 amp circuit pretty heavily, but two 15-amp circuits could handle the load with no trouble. To stage your light show, all you have to do is locate two separate circuits as described and run a few extensions.

For either a permanent or temporary light show, you may want to suit the light show to the available electric power rather than building up the power to run the show. In this case, suppose you find that you have available just two circuits to work with, perhaps, 10-amp fuses. This is a total of 20 amperes. Figuring the same 115 volts, you can play with about 2,300 watts. This amount of power will swing the two 500-watt projectors and the 500 to 700 watts of light boxes, but you had better not throw in a third 500-watt projector unless it's fitted with a low-wattage lamp. (Low wattage projection lamps are available that will interchange directly with their bigger brothers.)

EXTENSION CORDS

Finding the circuits is simple, but running the extensions takes a certain amount of knowledge. For instance, do you know the rating of your extensions? The plugs may well say that they are rated for 15 amps at 125 volts, but does this mean that the extension cord can carry 15 amps without setting the world on fire? Probably your answer to this one is a simple negative. The power carrying capacity of any extension is dependent on the diameter or gauge of its wire and its length.

Most extensions, especially the cheaper ones, are woefully skimpy. #18-gauge wire turns up in extensions

CURRENT CAPACITY OF FLEXIBLE CORDS

Gauge of Wire	Rubber Type Cords PO,C, PO,P,PW,K, E, and EO Thermoplastic Type ET Armored Type CA	Heavy Rubber or Thermoplastic Type S,SO,SJ,SR, SJO,SV POSJ,SP,SRT, SJT,SVP, SPT,ST, AFSJ	Asbestos Type Cord AVPO AVPD	Asbestos Type Cord HC, HPD,HSJ, HS,HPN, AFS,AFSJ
No. 18	5 amp	7amp	10 amp	17 amp
No. 16	7 amp	10 amp	15 amp	22amp
No. 14	15 amp	15 amp	20 amp	28 amp
No. 12	20 amp	20 amp	30 amp	36 amp
No. 10	25 amp	25 amp	35 amp	47 amp

MAXIMUM DISTANCE IN FEET FOR TYPE "R" RUBBER COVERED WIRE WITH 2 PER CENT VOLTAGE DROP AT 115 VOLTS

Wire Gauge	Maximum capacity in milli-amperes	Current Consumption in Amperes					
		5	10	15	20	25	35
-14	15	90 ft.	45 ft.	30 ft.			
12	20	140 ft.	70 ft.	50 ft.	37 ft.		
10	25	220 ft.	110 ft.	75 ft.	60 ft.	45 ft.	
8	35	360 ft.	175 ft.	125 ft.	90 ft.	75 ft.	55 ft.
6	45	560 ft.	28 ft.	190 ft.	150 ft.	120 ft.	85 ft.

all too frequently. A 36-foot length of #18 wire will drop about 2-1/2% of its voltage at a load of only 5.8 amperes. In 72 feet, the same wire will lose 5%. For a light show, this is obviously inadequate. At loads of more than 6 or 7 amps, such a wire will begin to heat up and can become dangerous at anything much greater.

The solution is to go to heavier conductors. The minimum should be a #16, and a #14 is better still. There should be no need to go to #12 wire until your projectors or other power consumers reach about 1,000 watts.

To avoid general trouble, the basic rule is to use #14 or #16 gauge wire extensions and to keep them as short as possible. Remember, a neatly coiled 50-footer is still 50 feet long even if it is used to connect a projector only a few feet away from the socket. It will certainly cause some voltage drop; so if you can, use a 25-foot extension or even a shorter one if you have it.

Voltage drop will dim your lights and possibly foul up any other important electrical devices such as fan motors in projectors. Therefore, avoid it as much as possible.

You can easily test your extensions for the jobs you want them to do. All you need is a light bulb and an electrical load. Use the same test light with which you determined which outlets were on what circuits. Plug it into the extension. In addition to the bulb, add an electrical load such as a small soldering iron, a household iron, or even the very projector you plan to run from the extension. When you switch on the load, does the light become considerably dimmer? If it does, then some part of your circuit isn't up to the job. You can easily tell if any extension is up to the job by simply holding the wire in your hand. Any extension cord that becomes hot or

warm to the touch after a few minutes of operation of the intended load is a definite hazard. It should be replaced with another made from wire of the next heavier gauge.

CONTROLS

Controls for electrical devices are a whole different field, but they definitely come under the general heading of electrical power for light shows. These may be simple switches that turn the lights either on or off; they may be dimmer switches; or they may be relay switches. Each type of switch can do a job to improve your light show. Knowing how to use it may even help you save expensive equipment from serious damage.

On-off switches can be the kind that go in the electrical line; regular household switches can be mounted on a control panel or box; or special switches can be used. Most pieces of lighting equipment will come equipped with the switches, but it can be an advantage to have all your switches and controls on a central panel.

Such a panel can be built and wired quite easily and neatly. (See illustration on page 2). You will need switches capable of handling the current your equipment will draw. This information is always printed right on the switch, so it is not hard to find. For relatively light loads, you can also use household dining room dimmer switches that will let you turn your show on and off gradually. You may want to use relay switches for the same job. The panel containing these controls can be either permanent or temporary.

Dimmer switches cannot be used with equipment containing cooling fans unless the dimmer and switches are connected only to the lamps.

A permanent controlled panel for a built-in show can be constructed in a box or as part of the show itself. For a permanent show, you can even feed the power to the control panel directly from the fuse box without having plugs or outlets. Make sure, though, that it comes through a fuse or circuit breaker-equipped circuit. The panel can then either have the display lighting wired directly to it in a permanent fashion, or can have a series of sockets into which you can plug the various units of your lighting display.

A good feature for any electrical control box or panel, no matter how simple or fancy it may be, is a panic button. This is simply a heavy-duty switch connected to the main power line for the control panel. If anything should be dangerously wrong, you can kill everything before setting the world on fire.

Such a kill-switch is definitely an emergency insurance measure and is not intended for turning off the show. Remember those cooling fans in your projector and what internal heat can do to their expensive bulbs if you unplug them. Despite the chance of damaging expensive equipment by slowing it down suddenly, a panic button makes good sense for any complex system using electricity. After all, power that gets out of hand can be dangerous. A panic button will stop these *spitzensparkens* before everything is completely out of control.

The control box for a temporary display is basically similar to the permanent control panel for a fixed-base light show, but it must be complete in itself and portable. Here are a couple of ideas to consider when designing such a control box for your portable show. Use a recessed male plug for the main power line so the wire can be removed from the control box for more convenient carrying. This line and other extension wires for various elements in the light show can be neatly stored in a compartment built right into the control box, or they can be carried separately.

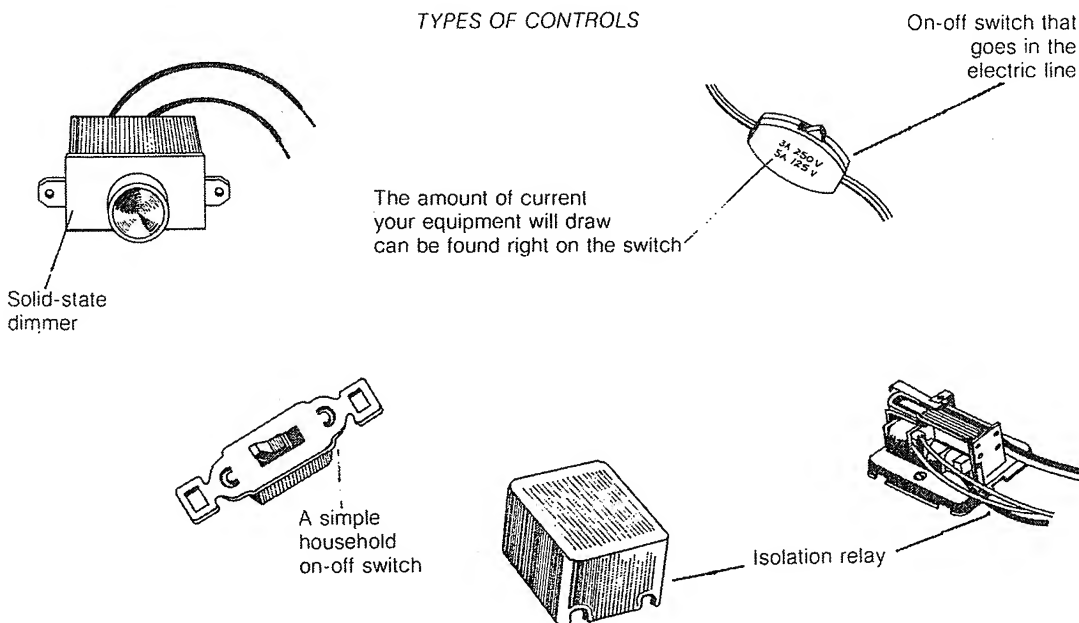
The idea of simply putting a regular household wall plug right on the side of your control box and then using a special power line with a male plug on each end is tempting, but not good. Remember Murphy's Law . . . "If something can go wrong, sooner or later it will." Think of the results if such a double-plug extension is inserted into two live sockets at the same time. If you don't have a recessed male plug, or have trouble finding one, simply use a 220-volt female socket or any other socket with a special type of plug. In that way, the ends of your power cord will be different, making it impossible to get into trouble. Above all, make sure that the power cord(s) for the box can carry the necessary current for everything controlled by it. In very large units, extra heavy conductors that can be connected directly to the main circuit breaker panel may be necessary.

Another thought for your control box is to label each outlet in some way. This can be done easily and can be a simple coding for your various units. It can take a form something like this: "20-amps, #2 on-off switch," or "50-amps, #5 dimmer." Self-sticking plastic label machine tape is great for this.

On-off switches for light boxes are simple enough, but central panel controls for projectors of any kind can cause problems. You may want to turn off the projector, but you most certainly do not want to turn off all power to it. This will kill the cooling fan and can seriously damage the projector or blow out the expensive projection lamp. When you shut down a projector, the thermal or timer switch will keep the fan going for a while to help prevent this kind of damage. Killing the power at the source is the same as unplugging the machine . . . it stops the fan.

The same thing is true when you want to put a dimmer on a projector. It will probably stop the fan before dimming the bulb and this leads to trouble with some dimmers: the fan motor will quickly burn out. There is an easy way around this problem . . . connect the dimmer "on"

TYPES OF CONTROLS



switch to the lamp in the projector rather than to the main power cord. To do this, you will have to open the case of the projector, find the two wires leading to the lamp, cut one of these, and splice in the two wires to the control. (See illustration at top of page 2.)

This sounds harder to do than it is in fact. One neat technique is to put the control right on the case of the projector or to put a plug with a by-pass switch on the case so you can either use the case-mounted control or plug a line to a remote control into the socket. Dimmer controls are usually used for controlling lights in a dining room and so are meant for light-duty use. They use electronic circuitry to perform their function without using excessive current or creating too much heat . . . long a problem with older types of stage dimmers. The older types worked by resistance and, aside from using a lot of current, often created a heat problem. The rating of the dimmers will be written right on its case.

Especially applicable to permanent light shows, relay switches let you handle heavy current loads from far removed locations without a voltage drop. They perform this trick in a simple manner. The relay is merely a remotely controlled electrical switch. Thus you can mount it right in the projector so that the current for the 500-watt bulb travels through the power cord without becoming detoured to a control panel 50 or even 500 feet away.

(See illustration below.) The wires to the control switch for the relay can be of extremely light gauge material because they need only carry enough current to trip the relay. Usually this is in the area of 30 volts.

An incidental advantage to using relays is that your community's electrical inspectors won't worry about the way you wire them or how many wires you tape together. These inspectors usually concern themselves with 110-volt or higher voltage installations.

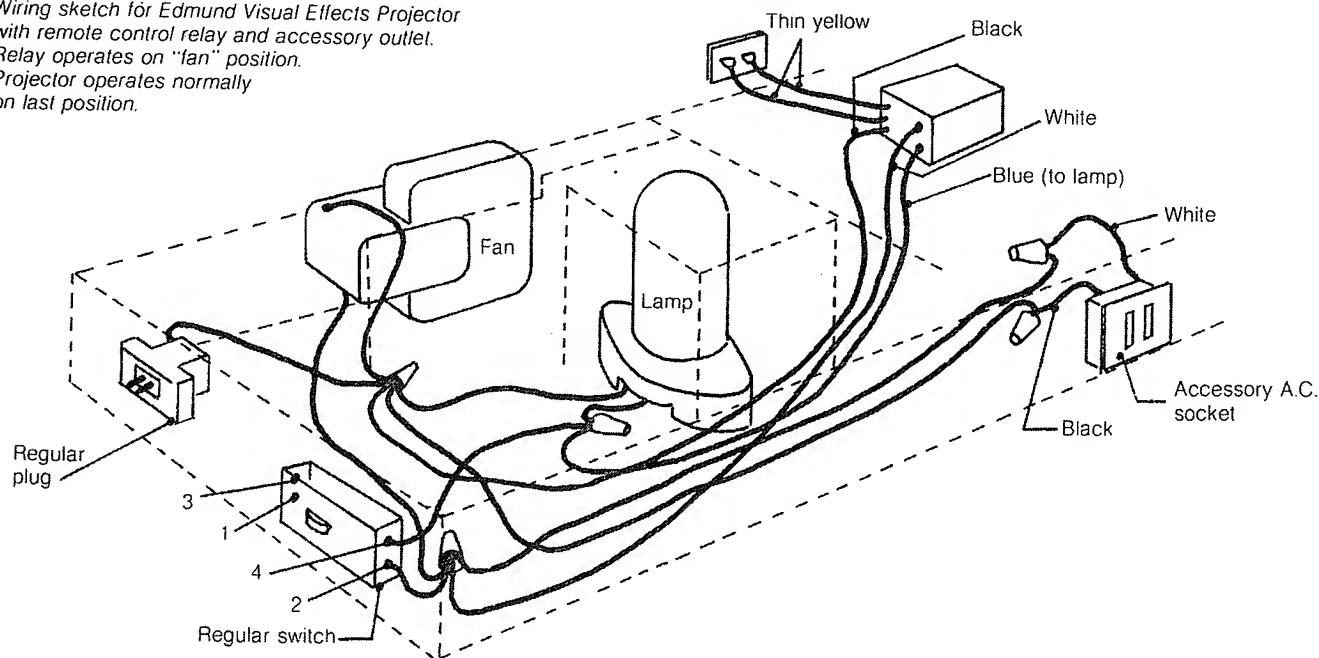
Finally, a quick recapitulation on electricity for light shows:

- 1—Don't overload the circuit.
- 2—Keep wiring adequate for the job and as short as possible to reduce voltage drop.
- 3—Make sure any external controls will not damage your equipment.

That's really all there is to it. Practical electricity for the purpose of putting on a light show need not be difficult or complex. Obey the natural electrical laws and you'll have a potentially successful light show. Ignore them at your peril.

The techniques described in this chapter are only the basics needed to use electrical power successfully for running a home light show. For information on household wiring and electricity, see your local library for a book on the subject.

Wiring sketch for Edmund Visual Effects Projector with remote control relay and accessory outlet. Relay operates on "fan" position. Projector operates normally on last position.





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